State of Mississippi

WATER POLLUTION CONTROL PERMIT

Permit to Discharge Wastewater in Accordance with National Pollutant Discharge Elimination System

THIS CERTIFIES

West Rankin Utility Authority Wastewater Treatment Facility
Interstate Drive
Between Diane Drive and Weems Street
Richland, MS
Rankin County

has been granted permission to discharge wastewater in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit. This permit is issued in accordance with the provisions of the Mississippi Water Pollution Control Law (Section 49-17-1 et seq., Mississippi Code of 1972), and the regulations and standards adopted and promulgated thereunder, and under authority granted pursuant to Section 402(b) of the Federal Water Pollution Control Act.

Mississippi Environmental Quality Permit Board

Mississippi Department of Environmental Quality

Issued/Modified: APR 1 4 2015
Expires: MAR 3 1 2020

Permit No. MS0061743
Agency Interest # 56736

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Subject Item: **Outfall 001 (Treated Domestic Wastewater)**

RPNT0000000001: MS0061743-001

Such discharges shall be limited and monitored by the permittee as specified below:

Parameter	Discharge Limitations							Monitoring Requirements		
	Quantity / Loading Average	Quantity / Loading Maximum	Quantity / Loading Units	Quality / Conc. Minimum	Quality / Conc. Average	Quality / Conc. Maximum	Quality / Conc. Units	Frequency	Sample Type	Which Months
Oxygen Demand, carbonaceous biochemical, 5-day (20 degrees C) Effluent	1000 Monthly Average	1501 Maximum Weekly Average	pounds per day	******	6 Monthly Average	9 Maximum Weekly Average	mg/L	Daily	24-hr Composite	May-Oct
Oxygen Demand, carbonaceous biochemical, 5-day (20 degrees C) Effluent	2001 Monthly Average	3002 Maximum Weekly Average	pounds per day	******	12 Monthly Average	18 Maximum Weekly Average	mg/L	Daily	24-hr Composite	Nov-Apr
Oxygen Demand, carbonaceous biochemical, 5-day (20 degrees C) Influent	Report Monthly Average	Report Maximum Weekly Average	pounds per day	******	Report Monthly Average	Report Maximum Weekly Average	mg/L	Daily	24-hr Composite	Jan-Dec
Oxygen, dissolved Effluent	******	******	******	6.0 Minimum	******	******	mg/L	Daily	24-hr Composite	Jan-Dec
Oxygen, dissolved In Aeration Unit	******	******	******	Report Minimum	******	Report Maximum	mg/L	Daily	24-hr Composite	Jan-Dec
pH Effluent	******	******	******	6.0 Minimum	******	9.0 Maximum	SU	Daily	Grab Sampling	Jan-Dec
Phosphorus (Total) Effluent	434 Monthly Average	651 Maximum Weekly Average	pounds per day	******	Report Monthly Average	Report Maximum Weekly Average	mg/L	Daily	24-hr Composite	Jan-Dec
Sludge Settleability 30 Minute In Aeration Unit	******	******	******	Report Minimum	******	Report Maximum	ml/L	Daily	Measurement	Jan-Dec

AI0000056736 (continued):

Limitation Requirements:

Condition No.	Parameter	Condition
L-8		Total Recoverable Antimony ---- MQL 60 Total Recoverable Arsenic ---- MQL 10 Total Recoverable Beryllium ---- MQL 5 Total Recoverable Cadmium ---- MQL 0.15 Total Recoverable Chromium ---- MQL 10 Chromium (Hex) ---- MQL 10 Total Recoverable Copper ---- MQL 5 Total Recoverable Lead ---- MQL 1.18 Total Recoverable Mercury ---- MQL 0.012 Total Recoverable Nickel (Freshwater) ---- MQL 29 Total Recoverable Selenium ---- MQL 2 Total Recoverable Silver ---- MQL 0.98 Total Recoverable Thallium ---- MQL 10 Total Recoverable Zinc ---- MQL 50 Free Cyanide ---- MQL 5.2 Phenol ---- MQL 10 Pentachlorophenol ---- MQL 6.7 Hardness (in mg/l as $CaCO_3$) If the most stringent EPA approved method has a MQL that is not the same as or more stringent than the given MQL for the pollutants above, then the most stringent EPA approved method must be used. [40 CFR]
L-9		In order to complete the requirements of Section E, Toxicity Testing Data, of the Form 2A application the permittee shall perform the monitoring described in Condition No. M-1 through M-6 of the permit. The toxicity of the effluent as the chronic value (IC25) shall be greater than or equal to 10.05%. Chronic Bioassay evaluations shall begin 90 days after the facility has been discharging for a period of one year. The chronic bioassay evaluations shall be conducted once per quarter for a period of one year. Monitoring results shall be compiled and submitted to Mississippi Environmental Quality Board, POSTMARKED NO LATER THAN THE 28TH DAY OF THE MONTH FOLLOWING THE COMPLETION OF THE MONITORING. [40 CFR]

AI0000056736 (continued):

Record-Keeping Requirements:

Condition No.	Condition
R-1	Recording of Results For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall maintain records of all information obtained from such monitoring including: (1) The exact place, date, and time of sampling; (2) The dates the analyses were performed; (3) The person(s) who performed the analyses; (4) The analytical techniques, procedures or methods used; and (5) The results of all required analyses. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(29)(a).]

AI0000056736 (continued):

Submittal/Action Requirements:

Condition No.	Condition
S-7	Expiration of Permit At least 180 days prior to the expiration date of this permit pursuant to the State law and regulation, the permittee who wishes to continue to operate under this permit shall submit an application to the Permit Board for reissuance. The Permit Board may grant permission to submit an application later than this, but no later than the expiration date of the permit. [11 Miss. Admin. Code Pt. 6, R. 1.1.5.B(1).]

Narrative Requirements:

Definitions:

Condition No.	Condition
T-1	Definitions: General The permittee shall refer to 11 Miss. Admin. Code Pt. 6, R. 1.1.1.A for definitions of any permit term not specified in this permit. [11 Miss. Admin. Code Pt. 6, R. 1.1.1.A.]
T-2	Definitions: Monthly Average "Monthly Average" means the average of "daily discharges" over a calendar month, calculated as the sum of all "daily discharges" measured during a calendar month divided by the number of "daily discharges" measured during the month. The monthly average for fecal coliform bacteria is the geometric mean of "daily discharges" measured during the calendar month. In computing the geometric mean for fecal coliform bacteria, the value one (1) shall be substituted for sample results of zero. [11 Miss. Admin. Code Pt. 6, R. 1.1.1.A(44).]
T-3	Definitions: Daily Discharge "Daily discharge" means the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurements, the "daily average" is calculated as the average measurement of the discharge of the pollutant over the day. [11 Miss. Admin. Code Pt. 6, R. 1.1.1.A(15).]

AI0000056736 (continued):

Narrative Requirements:

Condition No.	Condition
T-19	Adverse Impacts The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of the permit that has a reasonable likelihood of adversely affecting human health or the environment. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(19).]
T-20	The permittee shall provide written notification to the Mississippi Commission on Environmental Quality no later than thirty (30) days after the loss of the permittee's certified operator. [11 Miss. Admin. Code Pt. 6, Ch. 1, Subch. 1.]
T-21	Representative Sampling Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored wastewater. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(28)(e).]
T-22	Reporting If the results for a given sample analysis are such that any parameter (other than fecal coliform) is not detected at or above the minimum level for the test method used, a value of zero will be used for that sample in calculating an arithmetic mean value for the parameter. If the resulting calculated arithmetic mean value for that reporting period is zero, the permittee shall report "NODI = B" on the DMR. For fecal coliform, a value of 1.0 shall be used in calculating the geometric mean. If the resulting fecal coliform mean value is 1.0, the permittee shall report "NODI = B" on the DMR. For each quantitative sample value that is not detectable, the test method used and the minimum level for that method for that parameter shall be attached to and submitted with the DMR. The permittee shall then be considered in compliance with the appropriate effluent limitation and/or reporting requirement. [11 Miss. Admin. Code Pt. 6, Ch. 1, Subch. 2.]
T-23	Reporting If the permittee monitors any pollutant as prescribed in the permit more frequently than required by the permit using test procedures approved under 40 CFR Part 136 or, in the case of sludge use or disposal, approved under 40 CFR Part 136 unless otherwise specified in 40 CFR Part 503, or as specified in the permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR or sludge reporting form specified by the Permit Board. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(15)(c)(2).]

AI0000056736 (continued):

Narrative Requirements:

Condition No.	Condition
T-37	Upsets- Definition "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(27).]
T-38	Upsets - Effect of an Upset An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the "conditions necessary for demonstration of upset" requirements of this permit are met. Any determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, shall not constitute final administrative action subject to judicial review. [11 Miss. Admin. Code Pt. 6, R.1.1.4.A(27).]
T-39	Upsets - Conditions necessary for demonstration of upset A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed contemporaneous operating logs, or other relevant evidence that: (1) An upset occurred and that the permittee can identify the cause(s) of the upset; (2) The permitted facility was at the time being properly operated; (3) The permittee submitted notice of the upset as required in 40 CFR 122.41(L)(6)(ii)(B)(24-hour notice of noncompliance); and (4) The permittee complied with any remedial measures required under 40 CFR 122.41(d) (Duty to Mitigate). [11 Miss. Admin. Code Pt. 6, R.1.1.4.A(27).]
T-40	Upsets - Burden of proof In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(27).]

AI0000056736 (continued):

Narrative Requirements:

Condition No.	Condition
T-52	Toxic Pollutants The permittee shall comply with any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) established under Section 307(a) of the Federal Water Pollution Control Act. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(26).]
T-53	Toxic Pollutants Notification Requirements The permittee shall comply with the applicable provisions of 40 CFR 122.42. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(26).]
T-54	Civil and Criminal Liability (1) Any person who violates a term, condition or schedule of compliance contained within this permit or the Mississippi Water Pollution Control Law is subject to the actions defined by law. (2) Except as provided in permit conditions on "Bypassing" and "Upsets", nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. (3) It shall not be the defense of the permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(24).)]
T-55	Oil and Hazardous Substance Liability Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject to under Section 311 of the Federal Water Pollution Control Act and applicable provisions under Mississippi Law pertaining to transportation, storage, treatment, or spillage of oil or hazardous substances. [11 Miss. Admin. Code Pt. 6, R. 1.1.4.A(23).]
T-56	Property Rights The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations. [11 Miss. Admin. Code Pt. 6, R. 1.1.5. E.]

GENERAL INFORMATION

West Rankin Utility Authority Wastewater Treatment Facility
Interstate Drive
Between Diane Drive and Weems Street
Richland, MS
Rankin County

Alternate/Historic Identifiers

ID	Alternate/Historic Name	User Group	Start Date	End Date
56736	West Rankin Utility Authority Wastewater Treatment Facility	Official Site Name	11/30/2011	
MS0061743	West Rankin Utility Authority Wastewater Treatment Facility	Water - NPDES	4/14/2015	3/31/2020

Basin: Pearl River Basin

Location Description:

Relevant Documents: Cover Letter, Form 2-A,

FACT SHEET

APPLICATION FOR
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
PERMIT TO DISCHARGE WASTEWATER TO WATERS
OF THE STATE OF MISSISSIPPI
June 23, 2015

Application No.: MS0061743

1. SYNOPSIS OF APPLICATION

   a. Name and Address of Applicant

      West Rankin Utility Authority Wastewater Treatment Facility
      PO Box 180807
      Richland, Mississippi 39218-0807

   b. Description of Applicant's Operation

      The collection and treatment of domestic wastewater

   c. Production Capacity of Facility

      20 MGD

   d. Description of Existing Pollution Abatement Facilities

      Applicant proposed to construct a activated sludge mechanical treatment plant with UV or Chlorine disinfection.

   e. Applicant's Receiving Water

      Pearl River

   f. Description of Discharges

      Proposed outfall 001 will discharge a monthly average of 20 MGD of biologically treated domestic wastewater.

2. PROPOSED EFFLUENT LIMITATIONS

   See Draft Permit

State of Mississippi

WATER POLLUTION CONTROL PERMIT

Permit to Discharge Wastewater in Accordance with National Pollutant Discharge Elimination System

THIS CERTIFIES

West Rankin Utility Authority Wastewater Treatment Facility
Interstate Drive
Between Diane Drive and Weems Street
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has been granted permission to discharge wastewater in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit. This permit is issued in accordance with the provisions of the Mississippi Water Pollution Control Law (Section 49-17-1 et seq., Mississippi Code of 1972), and the regulations and standards adopted and promulgated thereunder, and under authority granted pursuant to Section 402(b) of the Federal Water Pollution Control Act.

Mississippi Environmental Quality Permit Board

Mississippi Department of Environmental Quality

Issued/Modified: Permit No. MS0061743
Expires: Agency Interest # 56736

*** Draft Permit ***

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Subject Item: **Outfall 001 (Treated Domestic Wastewater)**
RPNT0000000001: MS0061743-001

Such discharges shall be limited and monitored by the permittee as specified below:

Parameter	Discharge Limitations							Monitoring Requirements		
	Quantity / Loading Average	Quantity / Loading Maximum	Quantity / Loading Units	Quality / Conc. Minimum	Quality / Conc. Average	Quality / Conc. Maximum	Quality / Conc. Units	Frequency	Sample Type	Which Months
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AI0000056736 (continued):

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AI0000056736 (continued):

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Condition No.	Condition
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AI0000056736 (continued):

Narrative Requirements:

Condition No.	Condition
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AI0000056736 (continued):

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Condition No.	Condition
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T-56	Property Rights The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations. [11 Miss. Admin. Code Pt. 6, R. 1.1.5. E.]

GENERAL INFORMATION

West Rankin Utility Authority Wastewater Treatment Facility
Interstate Drive
Between Diane Drive and Weems Street
Richland, MS
Rankin County

Alternate/Historic Identifiers

ID	Alternate/Historic Name	User Group	Start Date	End Date
56736	West Rankin Utility Authority Wastewater Treatment Facility	Official Site Name	11/30/2011	

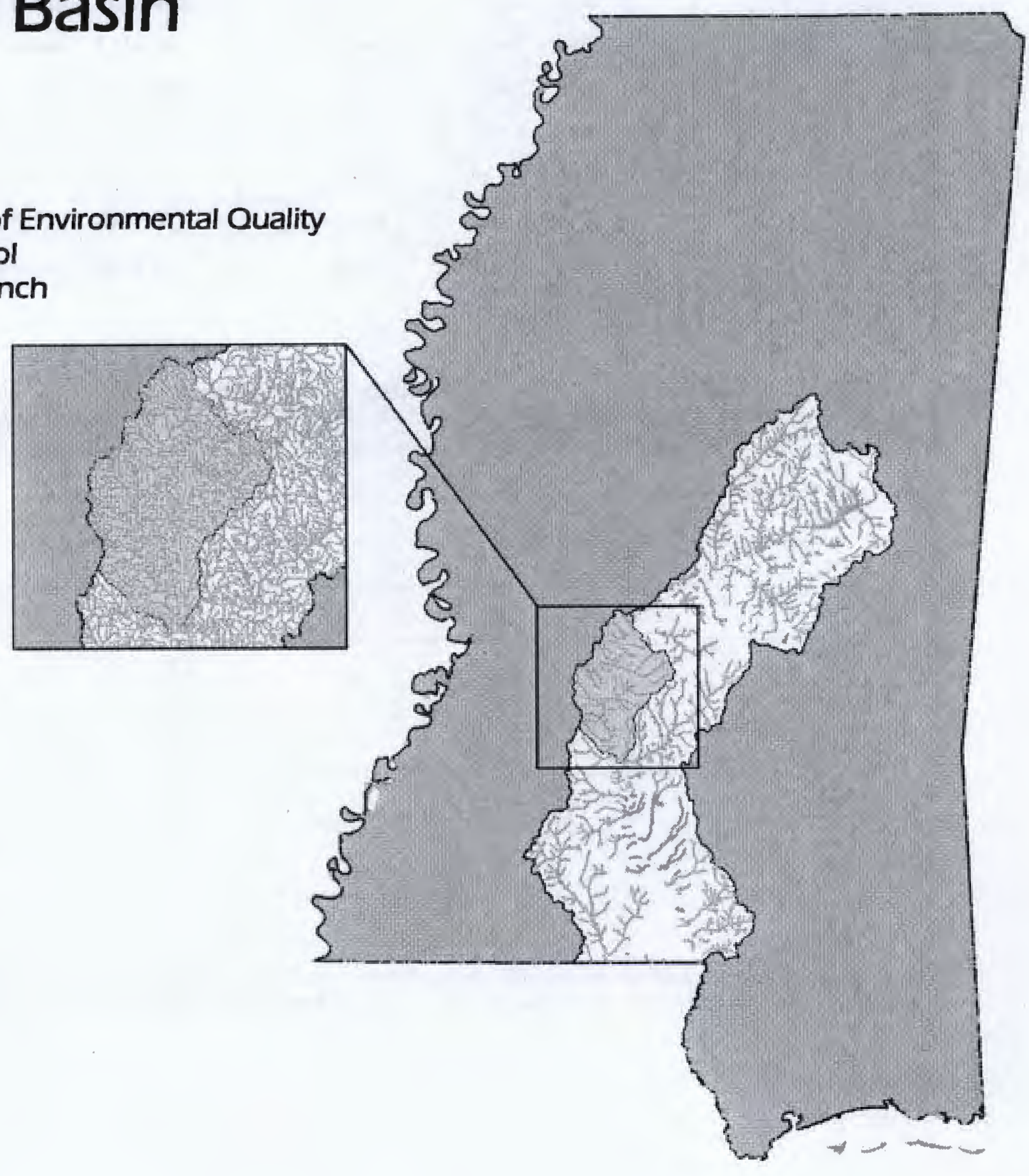
Basin: Pearl River Basin

Location Description:

Relevant Documents: Cover Letter, Form 2-A,

REVISED DRAFT
DECEMBER, 2014

Total Maximum Daily Load Total Nitrogen and Total Phosphorus For the Pearl River from Ross Barnett Reservoir to the Strong River Hinds, Rankin, Simpson, and Copiah Counties Pearl River Basin



Prepared By

Mississippi Department of Environmental Quality
Office of Pollution Control
Modeling and TMDL Branch

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Mississippi Department
of Environmental Quality

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EXECUTIVE SUMMARY

Figure 1 Pearl River

This TMDL updates the 2009 Pearl River Nutrient TMDL for the segment of the river from the Ross Barnett Reservoir to the confluence with the Strong River. This segment is the county boundary between Hinds and Rankin Counties and Copiah and Simpson Counties. It includes several point source discharges. The pollutants of concern are total phosphorus (TP) and total nitrogen (TN).

The previous 2014 Draft TMDL went to public notice March 20, 2014. MDEQ received several comments on that version and in response, prepared this 2014 revised draft version of the TMDL. This revised draft will be sent for public review as well. The 2009 TMDL for the Pearl River utilizes a mass balance approach for TMDL development. It called for a 56% reduction in the TP load to the river. This revised draft updated 2014 TMDL uses dynamic computer model simulations to provide more accurate estimates of the TMDL for this segment of the Pearl River. The modeling allows simulation of the nutrients available in the river and the response variables of dissolved oxygen, dissolved oxygen saturation, and chlorophyll-a. By manipulating the nutrient level reductions, the corresponding responses can be studied to predict expected outcomes. This TMDL provides an estimate of the TN and TP allowable in this river to produce the predicted outcomes.

The limited nutrient information and estimated existing concentrations indicate reductions of nutrients can be accomplished with implementation of best management practices (BMPs) and discharge limitation of TP from the point sources.

The new water quality modeling available for this TMDL indicates an overall reduction of 70% TP will restore water quality in this segment. The TN TMDL will be set based on the reduction of TP. Algal Growth Potential Tests (AGPT) indicate the river is nutrient limited therefore a reduction of the over abundant TP is appropriate and will reduce the combined nutrient pollution in the river.

The nonpoint source loads dominate the loading of nutrients in the river. Modeling indicates that if all of the point source loads were removed, the river would remain

INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. This TMDL covers a portion of the 2008 §303(d) listed segments shown in Figure 3, specifically the Pearl River from the Ross Barnett Reservoir to the confluence with the Strong River.

This segment already has an approved nutrient TMDL (2009) that was developed utilizing a mass balance approach for the entire River. This 2014 TMDL uses dynamic computer model simulations (EFDC and WASP) to provide computer simulated causal and response loading for this segment of the Pearl River. This allows for the study of the fate and transport of TN and TP and the response variable chlorophyll-a. The model also has the capability to study the reduction of TN or TP, and select the most efficient pathway toward nutrient pollution control.

1.2 Listing History

The segment was originally listed by evaluating the basin for water bodies that were potentially impaired due to activities within the watersheds. There are no state numeric criteria in Mississippi for nutrients. These numeric criteria are currently being developed by MDEQ. The 2009 TMDL utilized a mass balance approach to determine the TMDL values for TN and TP. Literature values were used to establish the NPDES Permit limits for the major POTWs included in the 2009 TMDL. A second effort began in 2011 to update the 2009 TMDL. That effort was abandoned after determining that better computer modeling would be available in 2013. This 2014 Revised Draft TMDL effort is based on that newer 2013 computer modeling.

1.3 Applicable Water Body Segment Use

The water use classifications are established by the State of Mississippi in The Administrative Procedures Act Rules Title 11, Part 6, Chapter 2: Mississippi Commission on Environmental Quality Regulations for Water Quality Criteria For Intrastate, Interstate, And Coastal Waters Rules 2.2 and 2.4 (MDEQ, 2014).[1] The designated beneficial use for this segment of the Pearl River is Recreation and Aquatic Life Use Support (fish & wildlife classification).

1 Source: Miss. Code Ann. §§ 49-2-1, et seq. and 49-17-1, et seq.

dissolved solids, sediment, turbidity, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated use. (MDEQ, 2014)." 3

1.5 Selection of a TMDL Endpoint

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by meeting the load and wasteload allocations specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses.

Excessive nutrient concentrations in a large river can produce an overabundance of algae that create eutrophic conditions in the river. The algae, through photosynthesis, produce oxygen when exposed to sunlight, and take up oxygen during the night. This diurnal swing in oxygen levels in the stream could lead to an aquatic life impact due to the lack of oxygen available instream. The EFDC / WASP models can simulate this natural phenomenon and predict chlorophyll-a levels as a response to the nutrients (TN and TP) available in the stream.

The WASP model was calibrated to several data sets where dissolved oxygen levels and chlorophyll-a levels were monitored instream during critical climactic conditions in 2012. By calibrating the model to known critical conditions, other less critical conditions can be predicted by the model. (See Appendix A.) The critical cell location determined by the model output for this segment is near Hopewell, MS shown in Figure 5 below (Cell 360). This is also shown in Figure 4 on the previous page which shows the entire model cell structure. The highlighted cell is the critical cell in the model.

The critical cell was identified by reviewing the model output for all of the cells and by comparison identifying the area that was most impacted by the pollutant loading in the model. The comparisons are made both in time and space as the critical condition could be in a different location based on the conditions in the model inputs of weather, flows, pollutant loads, etc.

This TMDL is based on a reaction to reducing nutrient concentrations and studying the corresponding chlorophyll-a and dissolved oxygen levels in the river. Model studies were completed to evaluate which nutrient reduction provided the best control of the response variables in the stream. The model was run with a series of reductions to TP, then with a series of reductions to TN, and finally with combinations of reductions to both nutrients.

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3 Title 11, Part 6, Chapter 2, Rule 2.2.A.(3)

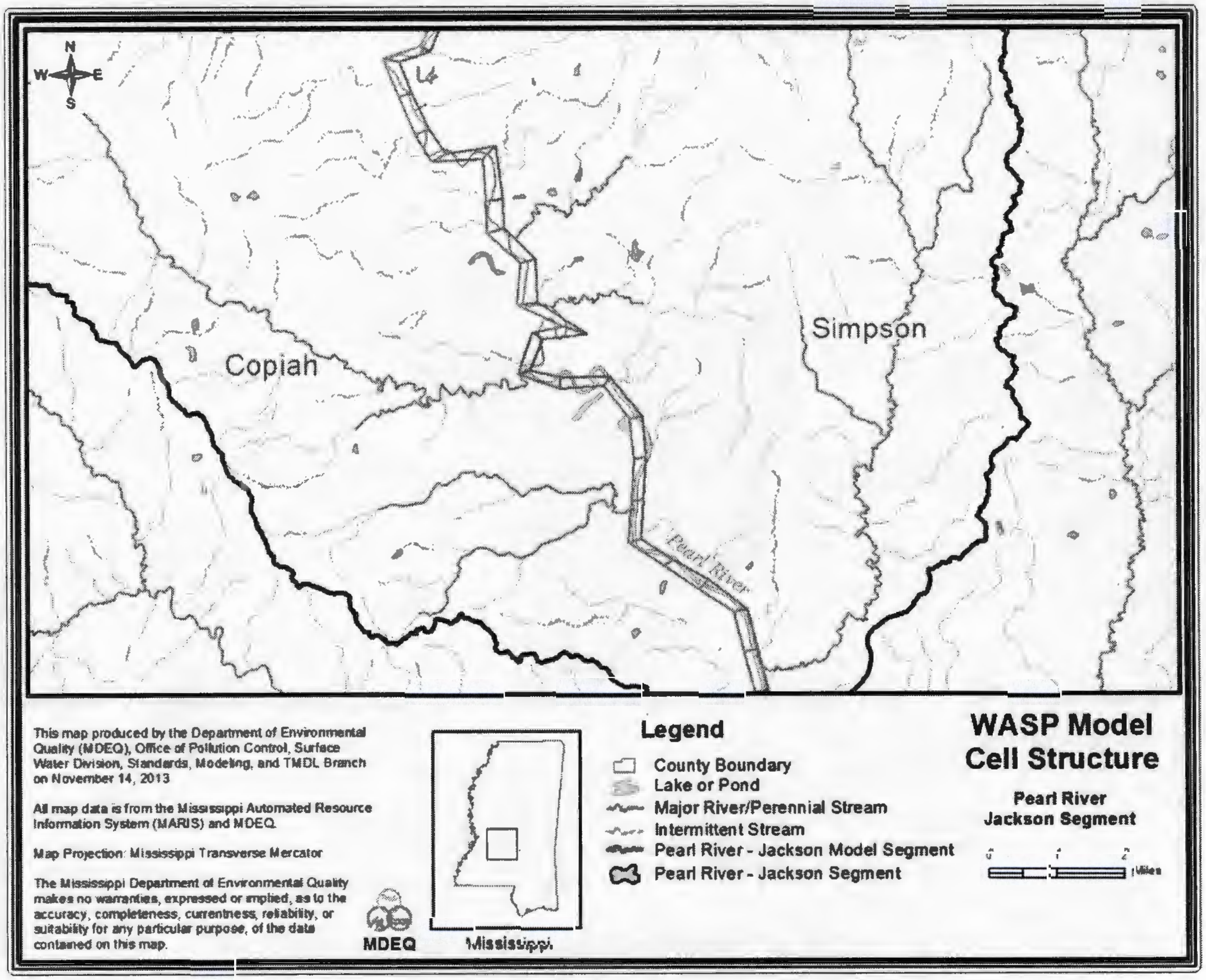


Figure 5 Critical Cell in WASP Model

The endpoint for the TMDL is based on the analysis of corresponding reactions to varying levels of TP reduction. Once the reduction level is selected, the TMDL nutrient load is calculated based on the model prediction for flow and concentration of TP. The overall reduction will provide a total TMDL which will then be divided between point and nonpoint sources (WLA and LA components of the TMDL).

WATER BODY ASSESSMENT

2.1 Water Quality Data

Figure 7 2012 Pearl River Monitoring Station

The Pearl River has had ongoing intensive water quality studies by MDEQ, EPA Region 4, Georgia Pacific, Inc., and LDEQ over the past decade. EPA Region 4 and MDEQ jointly studied the Pearl River above and at the Jackson POTWs in 2006. In 2006, 2008, and 2012 MDEQ completed algal growth potential tests on five locations throughout the watershed. Georgia Pacific Inc. studied the Pearl River in Lawrence County above and below their discharge point in 2010. In 2012, EPA Region 4 and MDEQ jointly studied the Pearl River in Copiah and Simpson Counties. All of these data sets were used in the preparation of the EFDC and WASP dynamic computer models of the Pearl River. Tetra Tech, Inc. created the models and calibrated and validated the model results to the monitoring data collected. The model development report and the data are included in this TMDL in Appendix A.

2.2 Nutrient Enrichment found in the Pearl River

2.2.1 Modeling Critical Location

During the 2012 monitoring period EPA Region 4 and MDEQ found an over-enrichment of TP and TN in the Pearl River. The critical condition, which was identified by modeling, was at the Pearl River Station 3 at Hopewell, MS. The model result of dissolved oxygen was super saturated in ranges of 150% to 160%. This is not a water quality standard in Mississippi, but other states in EPA Region 4 use this indicator for stream impairment.

2.2.2 Modeling Response Variables

The model results for diurnal flux between the minimum and maximum dissolved oxygen concentrations was approximately 8 mg/l. Ohio and Minnesota environmental departments use this indicator for stream impairment. TP model results were greater than 250 µg/l. Chlorophyll-a model results were as high as 80 µg/l. See Figure 8 below. Figure 98 on page 55 of Appendix A in the model report shows the comparison of the measured dissolved oxygen to the model output at this station. Figures 64 and 67 on

The AGPT results indicate that the river is nitrogen limited and needs to be driven back to being phosphorous limited. While this TMDL does not recommend a reduction to point source loading of TN, it does recommend quarterly monitoring of TN and applying the TN WLA load at these facilities.

The 2012 AGPT results are shown below. The 2008 and 2006 nutrient data and AGPT results are shown is Tables 7 and 8.

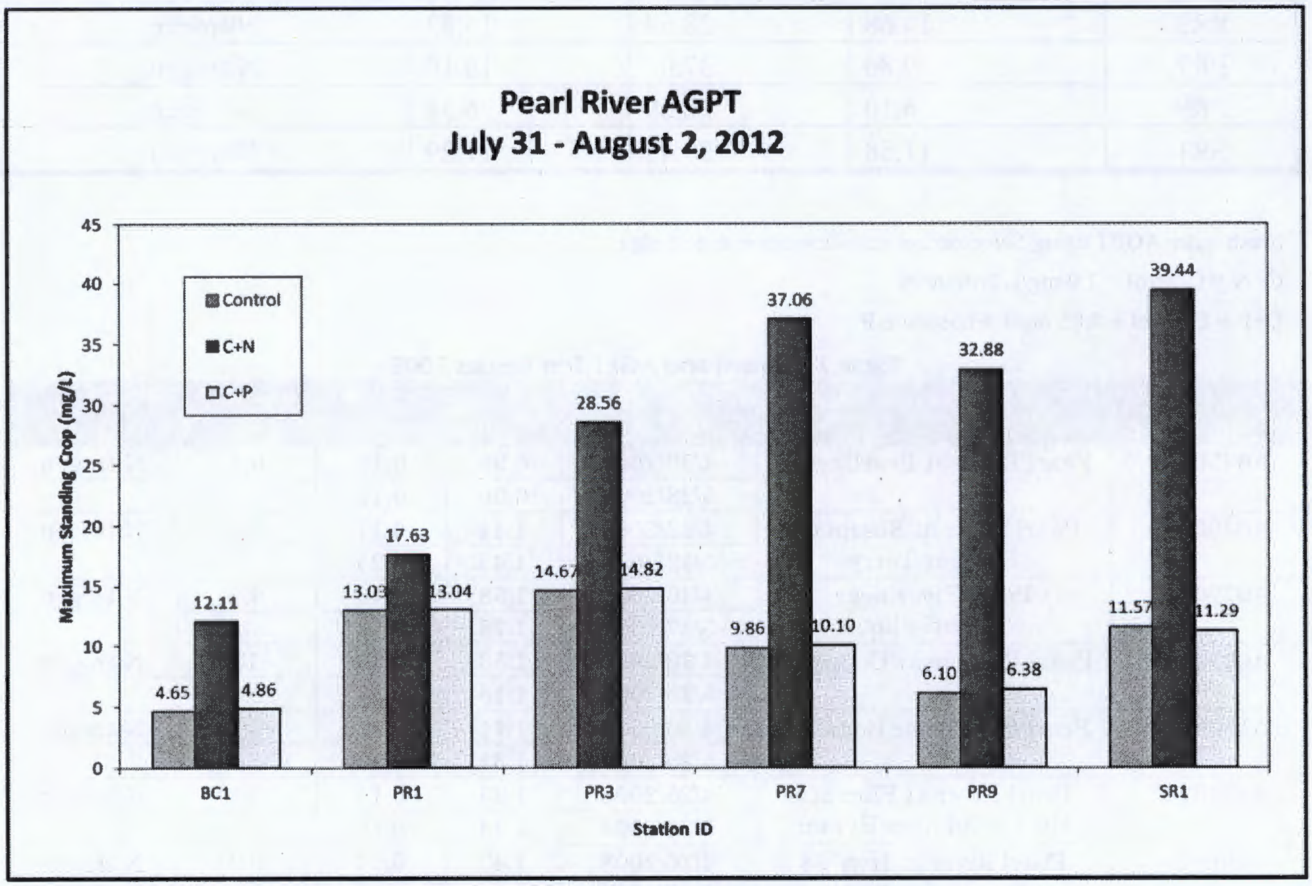


Figure 9 Chart showing AGPT Results 2012

A1210162	Pearl River at Florence Byrum Rd near Byram	8/23/2006	2.42	0.36		
		8/24/2006			38	Nitrogen
C0490033	Pearl River at Jackson at Water Works	8/23/2006	1.10	0.06	NA	NA

2.3 Assessment of Point Sources

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories of nutrients in the watershed and the amount of pollutant loading contributed by each of these sources. Under the CWA, sources are broadly classified as either point or nonpoint sources. Under 40 CFR §122.2, a point source is defined as a discernible, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters.

The NPDES program regulates point source discharges. Point sources can be described by two broad categories: 1) NPDES regulated municipal and industrial wastewater treatment plants (WWTPs) and 2) NPDES regulated activities, which include construction activities and municipal storm water discharges (Municipal Separate Storm Sewer Systems [MS4s]). For the purposes of this TMDL, all sources of nutrient loading not regulated by NPDES permits are considered nonpoint sources.

2.3.1 Primary Point Source Loads

Point source dominated freshwater systems are generally nitrogen limited. By controlling the phosphorous loads with a TP reduction, the streams can be converted to a phosphorus limited stream which is typical of unimpaired streams. (Thomann and Mueller, 1987).

The wastewater was characterized based upon the best available information. Discharge Monitoring Reports (DMRs) and direct effluent sampling provided the loading rates used in the models to represent the point sources. Where DMRs or direct sampling were not available, estimated concentrations of TN and TP were selected for different treatment types (USEPA 1997).

13147	Georgetown POTW	Georgetown	Copiah	31.869875	-90.155583	MS0020605
13203	Jackson POTW, Trahon and Big Creek	Jackson	Hinds	32.152164	-90.263889	MS0044059
13414	Terry POTW	Terry	Hinds	32.10595	-90.285008	MS0025224
13642	Autumn Light Personal Care Home	Terry	Hinds	32.091997	-90.285086	MS0023493
13710	Briar Hill Rest Home LLC	Florence	Rankin	32.182747	-90.126528	MS0029726
13723	Total Environmental Solutions Inc., Woodland Acres Subdivision	Florence	Rankin	32.178553	-90.123139	MS0030252
13744	B and G Utilities Inc., Brookwood Subdivision	Jackson	Hinds	32.211417	-90.268167	MS0031194
13795	TMJ LLC	Brandon	Rankin	32.210611	-89.956972	MS0033006
13844	Chukstop Car Wash	Jackson	Hinds	32.314278	-90.210833	MS0034991
13853	Wilson Enterprises, Quicky Car Wash	Richland	Rankin	32.206175	-90.150042	MS0035408
13872	N C Carwash	Jackson	Hinds	32.3035	-90.282528	MS0036471
13911	Rankin County School District, McLaurin Attendance Center	Florence	Rankin	32.143975	-90.023778	MS0038466
13933	High Place Retreat, The	Florence	Simpson	32.038414	-90.194889	MS0038971
13954	Poole Subdivision	Terry	Hinds	32.113639	-90.303944	MS0039845
13961	Ultimate Shine Car Wash	Jackson	Hinds	32.297806	-90.233639	MS0040096
13963	Rolling Hills Wastewater Inc., Rolling Hills Subdivision	Florence	Rankin	32.141531	-90.087181	MS0040134
13991	Hinds County School District, Gary Road Elementary	Byram	Hinds	32.191806	-90.299658	MS0042099
13998	Daily Equipment Company	Pearl	Rankin	32.268847	-90.079803	MS0042277
14000	Restoration Community Fellowship Church	Florence	Rankin	32.183161	-90.135514	MS0042579
14058	Friends of Children of Mississippi Inc., New Hope Headstart Center	Pearl	Rankin	32.190911	-90.077503	MS0044547
14062	Ridge Park, Wakeland Hills and Wildwood Subdivisions	Jackson	Hinds	32.220361	-90.336306	MS0044792
14076	Child Care Management Group, The Child Development Center	Byram	Hinds	32.198742	-90.297744	MS0045161
14095	Corporate Child Care Services Inc., Child Development Center	Terry	Hinds	32.199464	-90.297139	MS0045837
14153	Raworth and Harvel LLC, Country View Estates Mobile Home Park	Florence	Rankin	32.192861	-90.148583	MS0047856
14180	Ks Kids Learning Center Inc.	Pearl	Rankin	32.244492	-90.115678	MS0048488

are included in the WLAsw portion of this TMDL. As of March 2003, discharge of storm water from construction activities disturbing more than one acre must obtain an NPDES permit. The purpose of the NPDES permit is to eliminate or minimize the discharge of pollutants from construction activities. Since construction activities at a site are of a temporary, relatively short term nature, the number of construction sites covered by the general permit varies. The target for these areas is the same range as the TMDL target for the watershed. The WLAs provided to the NPDES regulated construction activities and MS4s will be implemented as best management practices (BMPs) as specified in Mississippi's General Storm Water Permits for Small Construction, Construction, and Phase I & II MS4 permits. Properly designed and well-maintained BMPs are expected to provide attainment of water quality standards.

There are 9 MS4 permits within the Pearl River Jackson Segment. These MS4 permits are listed in Table 7.

Table 10 MS4 Permits in Watershed

Permit ID #	MS4 Name
MSRMS4026	City of Brandon, MS4 Storm Water Management Program
MSRMS4028	City of Flowood, MS4 Storm Water Management Program
MSRMS4019	Hinds County, MS4 Storm Water Management Program
MSRMS4024	MDOT, MS4 Storm Water Management Program
MSRMS4031	Madison County, MS4 Storm Water Management Program
MSRMS4025	City of Pearl, MS4 Storm Water Management Program
MSRMS4035	Rankin County, MS4 Storm Water Management Program
MSRMS4029	City of Richland, MS4 Storm Water Management Program
MSS049786	City of Jackson, MS4 Storm Water Management Program

2.3 Assessment of Non-Point Sources

Non-point loading of nutrients and organic material in a water body results from the transport of the pollutants into receiving waters by overland surface runoff, groundwater infiltration, and atmospheric deposition. Total nitrogen is a combination of many forms of nitrogen found in the environment. Inorganic nitrogen can be transported in particulate and dissolved phases in surface runoff. Dissolved inorganic nitrogen can be transported in groundwater and may enter a water body from groundwater infiltration. Finally, atmospheric gaseous nitrogen may enter a water body from atmospheric deposition.

Unlike nitrogen, phosphorus is primarily transported in surface runoff when it is sorbed by eroding sediment. Phosphorus may also be associated with fine-grained particulate matter in the atmosphere and can enter streams as a result of dry fallout and rainfall (USEPA, 1999). However, phosphorus is typically not readily available from the atmosphere or the natural water supply (Davis and Cornwell, 1988). As a result, phosphorus is typically the limiting nutrient in most non-point source dominated rivers and streams, with the exception of watersheds which are dominated by agriculture and

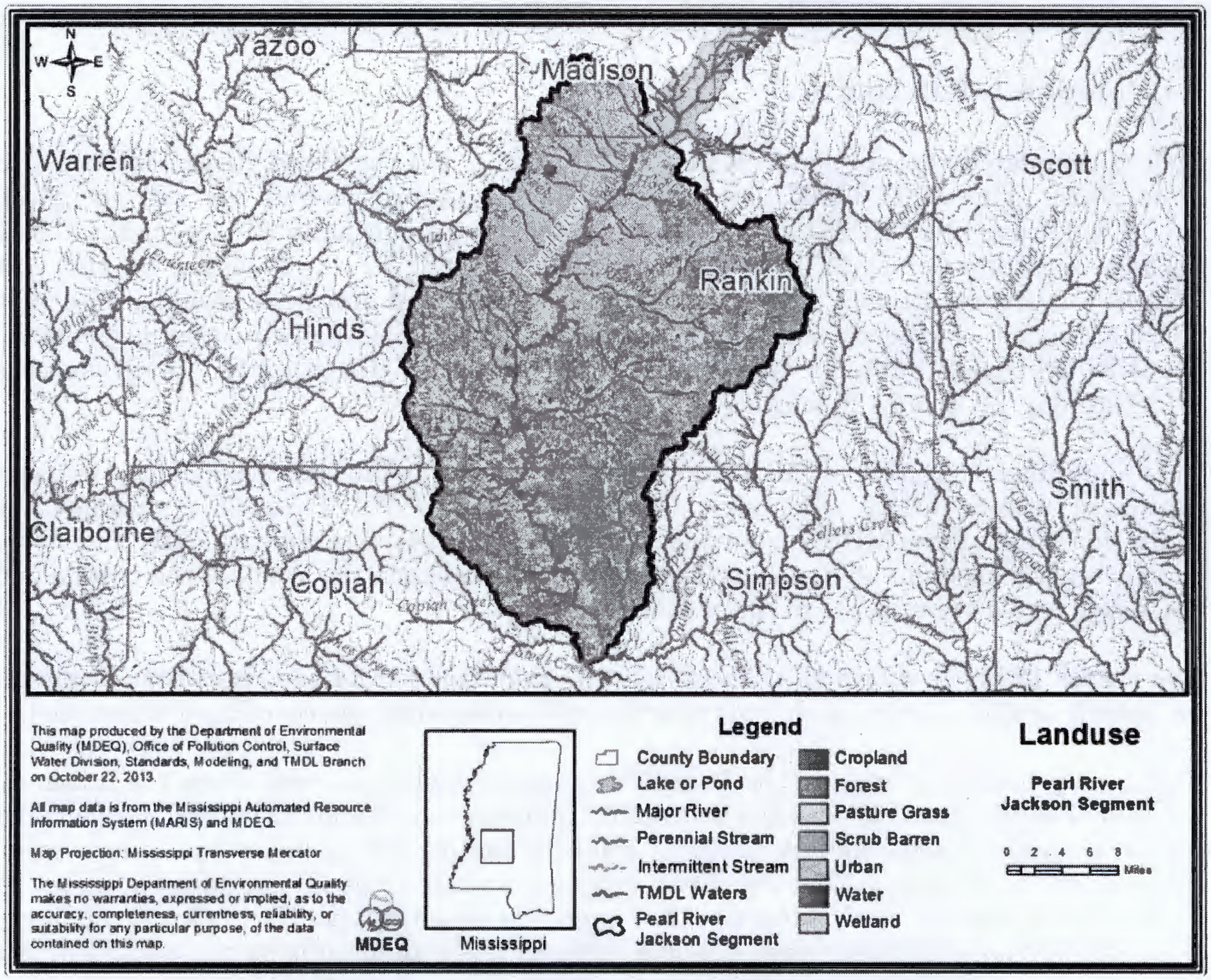


Figure 11 Landuse in the Pearl River Jackson Segment (2006 image)

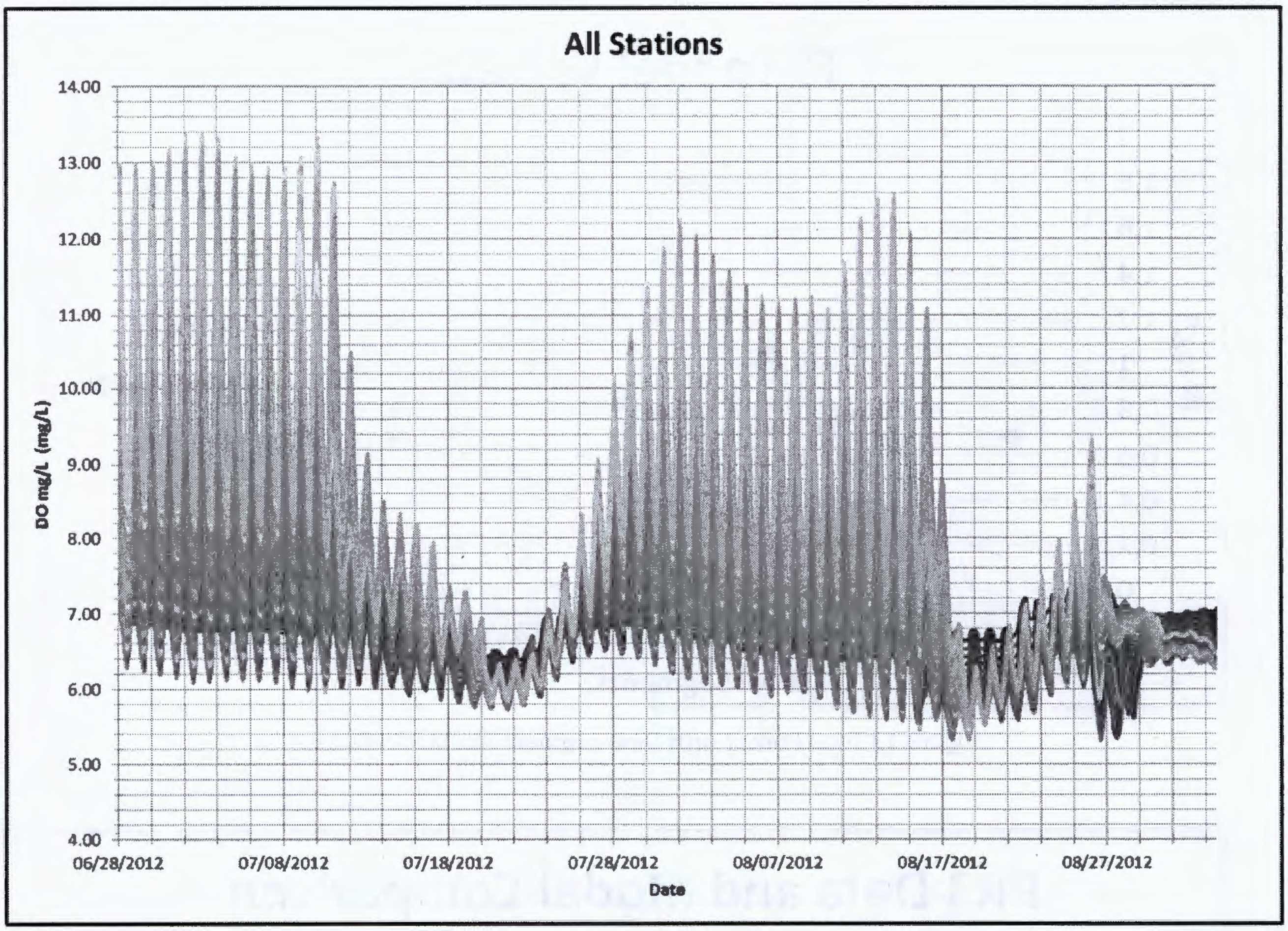
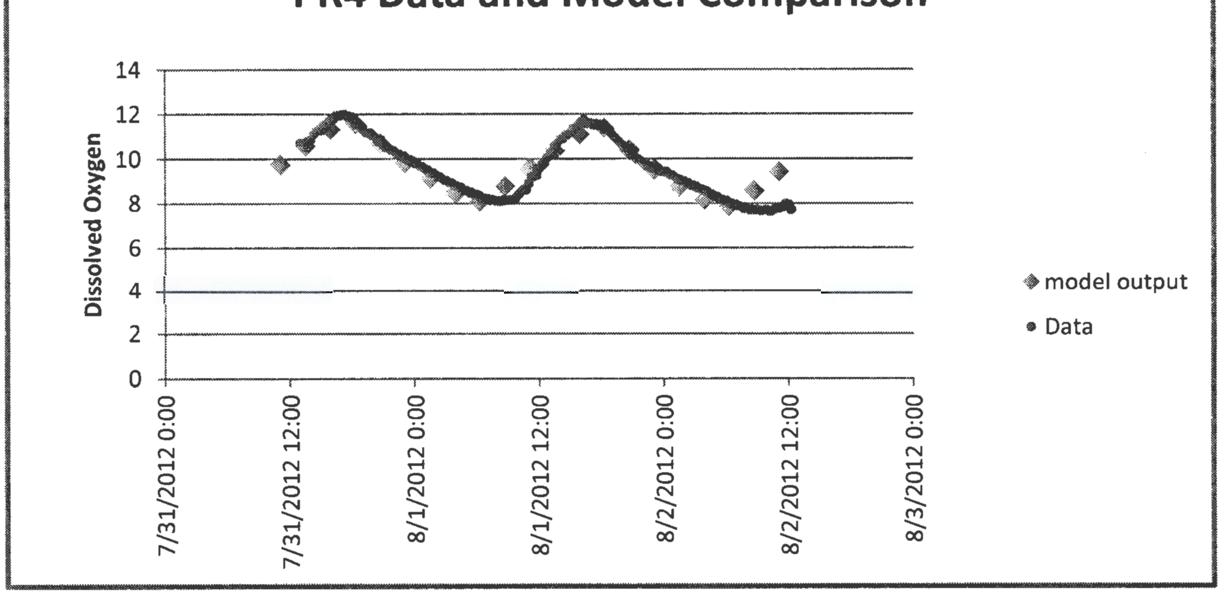


Figure 12 All Cells DO Model Output Critical Condition

3.3 WASP Model Output and Reaction Relationships

The WASP model provides a simulation of the water quality relationships and gives output for study. It is important to remember that this output is just that, a modeled simulation, not water quality data. The calibration of the model will adjust specific parameters to make the match between the data and the model output. Figures 13 - 16 show the comparison of the data and model output at different segments.

Figure 15 Dissolved Oxygen Data compared to Model Output



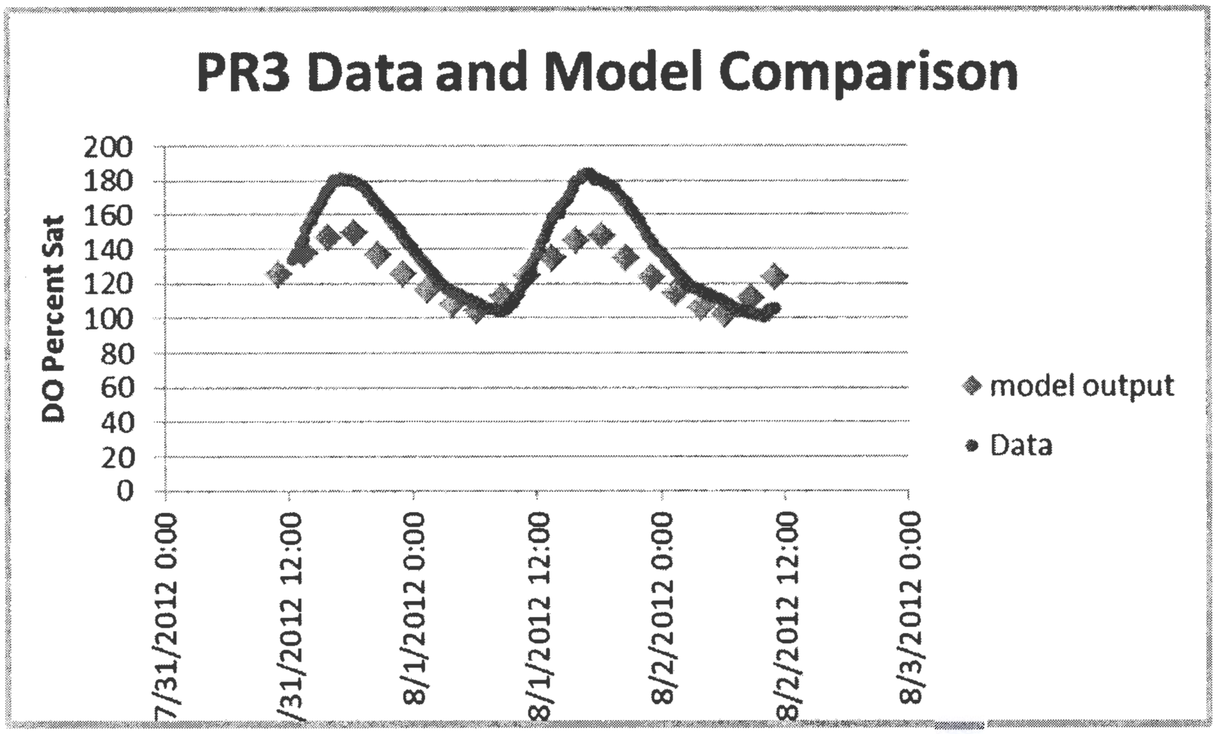


Figure 16 DO % Saturation Data compared to Model Output

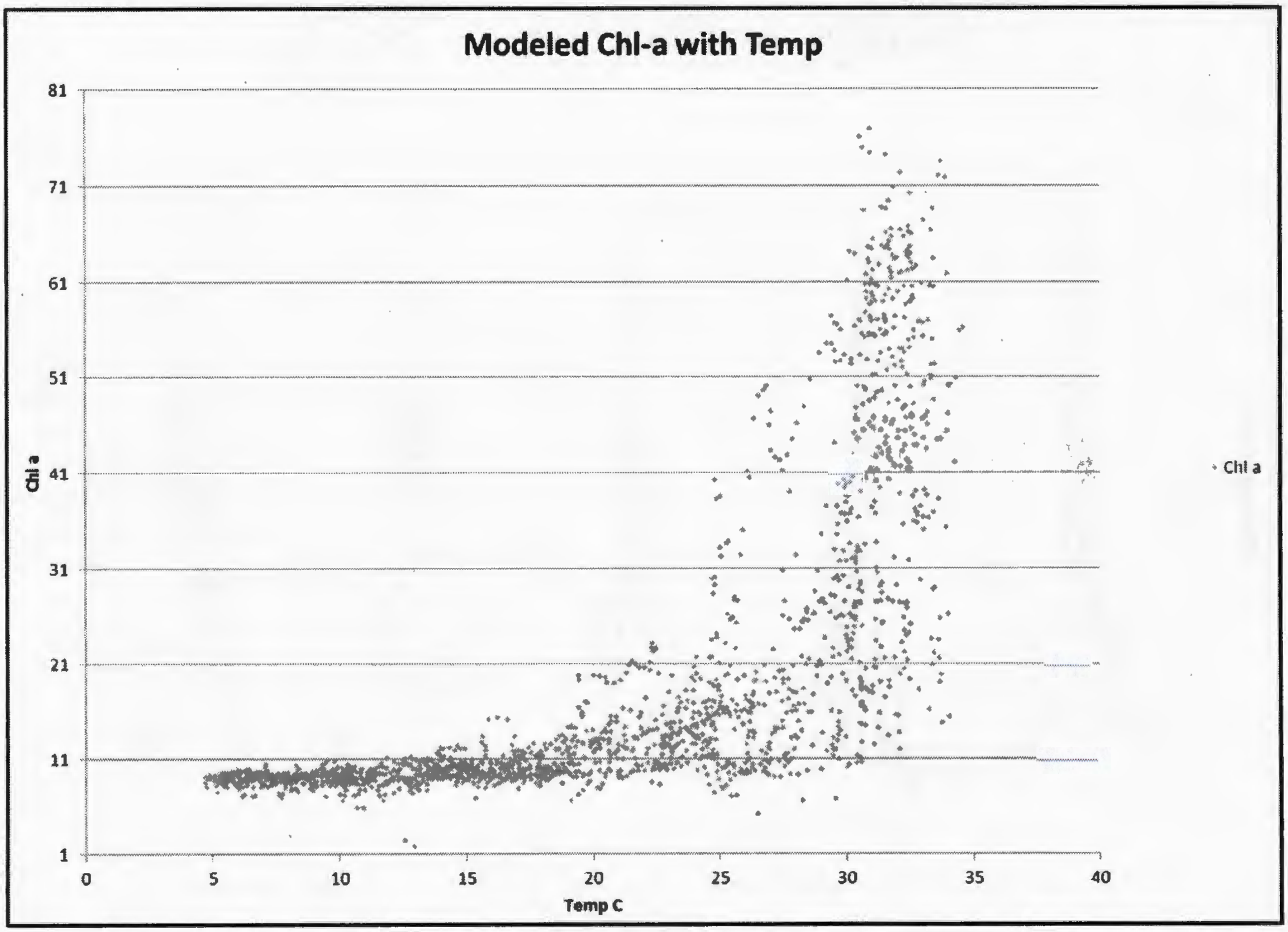


Figure 18 Model Output Chlorophyll-a vs. Temperature Model Cell 360

3.3 TP and TN Reduction Scenarios

The WASP model allows consideration of many variable reduction scenarios. The model output can show the best path forward to water quality restoration based on the model output. To set the nutrient reduction needed for restoration of the river, several nutrient reduction scenarios were considered.

3.3.1 Growing Season

The chlorophyll-a model output indicates this response variable is primarily a concern to water quality during the summer growing season. In Figure 19, the chlorophyll-a results are shown for 7 model runs. In each of these model runs, TP was reduced by an overall percentage. There was no significant change in the output until the TP reduction exceeded 50%. There was only minor change in chlorophyll-a in each of the model runs during the non-growing season. Based on this observation, this TMDL will focus on the summer growing season to establish seasonal nutrient NPDES permit limits.

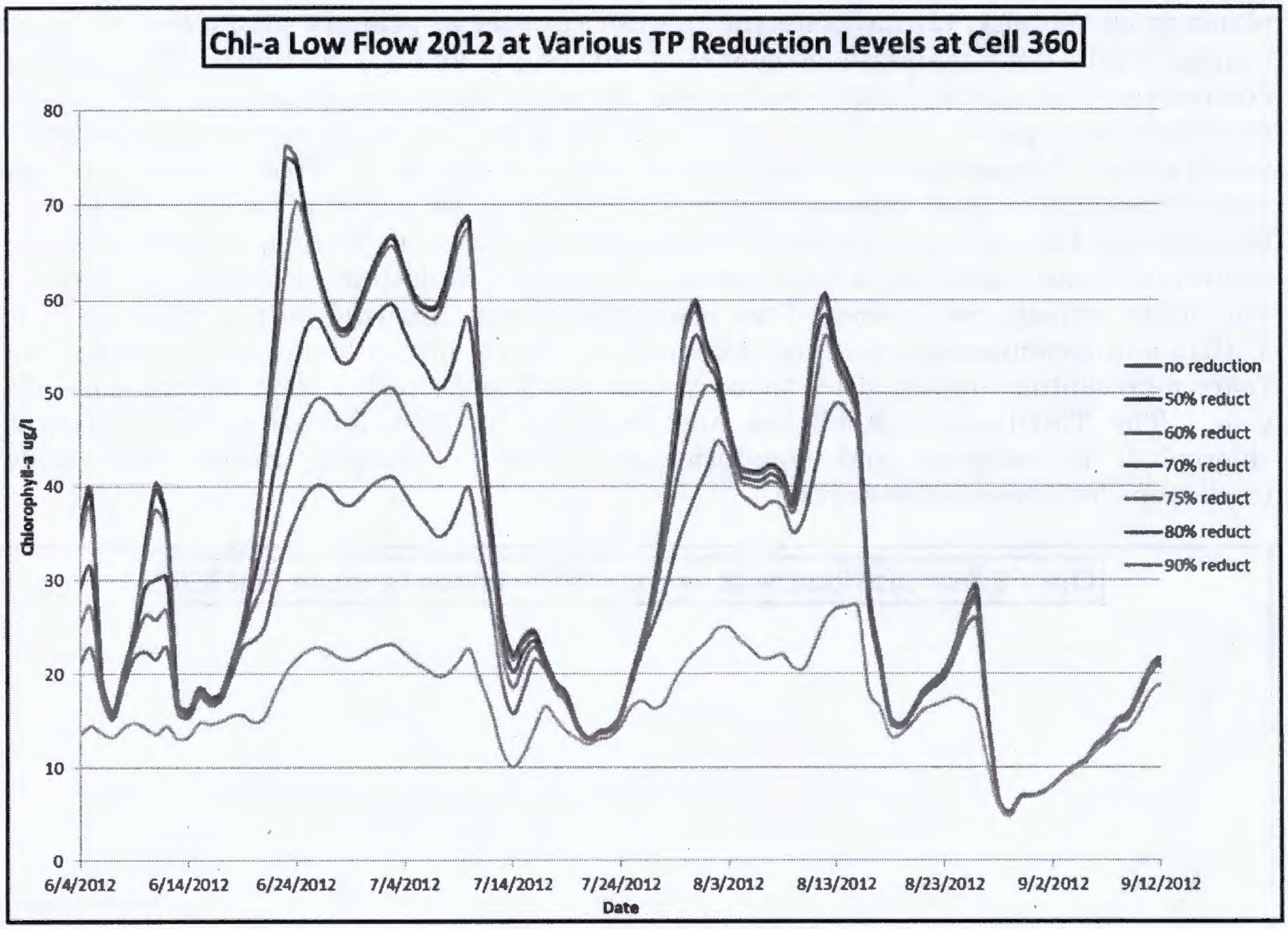


Figure 20 Focus of Critical Condition, 2012

3.3.2 Consider the Maximum Chlorophyll-a Levels

One consideration was the maximum chlorophyll-a response with each of the nutrient reduction scenarios. To observe this, the chart in Figure 19 above was converted to show the maximum to minimum results for each model run. Figure 21 shows these results.

Again, in the lower levels (non-growing season), there is minimal difference in all of the reduction scenarios. That is, the winter non-growing season is not impacted by a change in TP. On the left side of the chart, the reductions are more easily seen in the maximum chlorophyll-a values for each model run. For example, the TP model reduction scenario of 0.3; that is a 70% reduction to TP in the watershed, will limit the maximum chlorophyll-a to less than 60 µg/l.

The State of Florida Department of Environmental Protection (FPED) developed the St. Johns River Nutrient TMDL in 2008. They established a site-specific threshold for nutrient impairment for the freshwater zone based on chlorophyll a values. FDEP evaluated the maximum algal biomass levels that would (1) maintain the diversity of the

MDEQ reviewed the St. Johns River TMDL target process and applied the concept to the model output results obtained in this study. The chlorophyll-a model values were plotted in Figure 21 from maximum to minimum. The 90th percentile of these model scenarios were gathered and plotted. A trend analysis was then used to predict the percent reduction needed to achieve a 40 µg/l chlorophyll-a target with a limit of 10% exceedance. The results are shown in Figure 22 below. The 70% reduction run selected for this TMDL provided a 90th percentile value of 41.7. To find the percentage to meet the target of 40 the equation for the trend line was produced, and a calculated reduction scenario to meet the FDEP target is a reduction of 70.8%. MDEQ believes this comparison to an EPA R4 approved TMDL process shows similar results, and the TMDL target 70% reduction will protect the Pearl River.

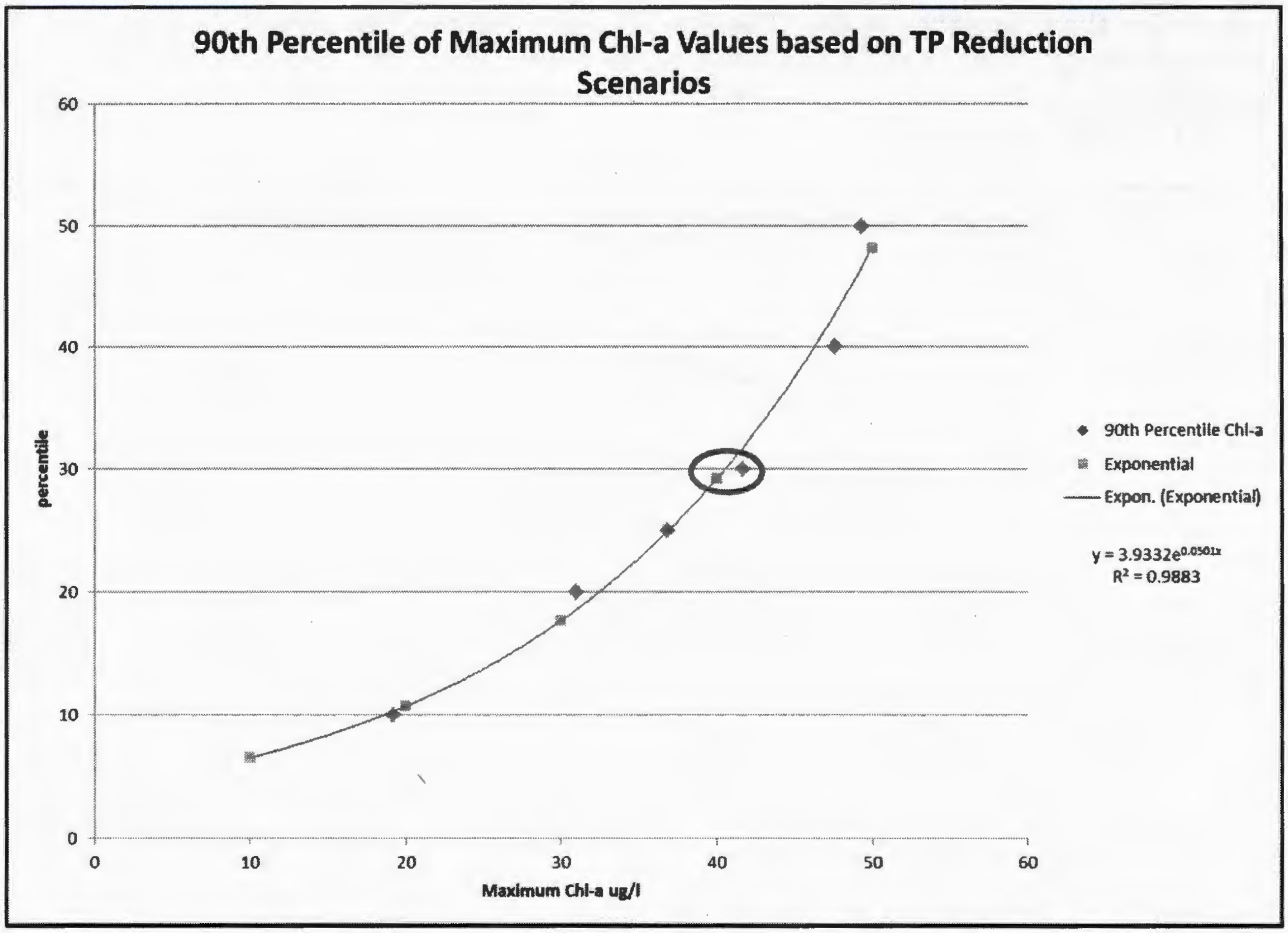


Figure 22 90th Percentile of Maximum Chl-a Model Output

3.3.4 Consider Dissolved Oxygen Diurnal Flux

Ohio Environmental Protection Agency published *A Method and Rationale for Deriving Nutrient Criteria for Small Rivers and Streams in Ohio.* This paper describes an analysis of the dissolved oxygen flux as a response to nutrient reduction. The difference between the minimum dissolved oxygen at night and the maximum dissolved oxygen during the afternoon provides the Diurnal Flux. The greater the flux, the more impact nutrients are having on the stream. If one targets a flux reduction, a nutrient limit could be derived.

Minnesota Pollution Control Agency published *Establishing Relationships Among In-stream Nutrient Concentrations, Phytoplankton Abundance and Composition, Fish IBI and Biochemical Oxygen Demand in Minnesota.* This paper addressed sestonic chlorophyll-a targets for large rivers. The paper recommends DO flux ranges for less than 3 to 4.5 mg/l for the southern more enriched region of Minnesota. These are based on regression models of DO ranges vs. chlorophyll-a.

MDEQ did not adopt these methods for this TMDL, but included this comparison in the TMDL to show the reduction scenario would address this method.

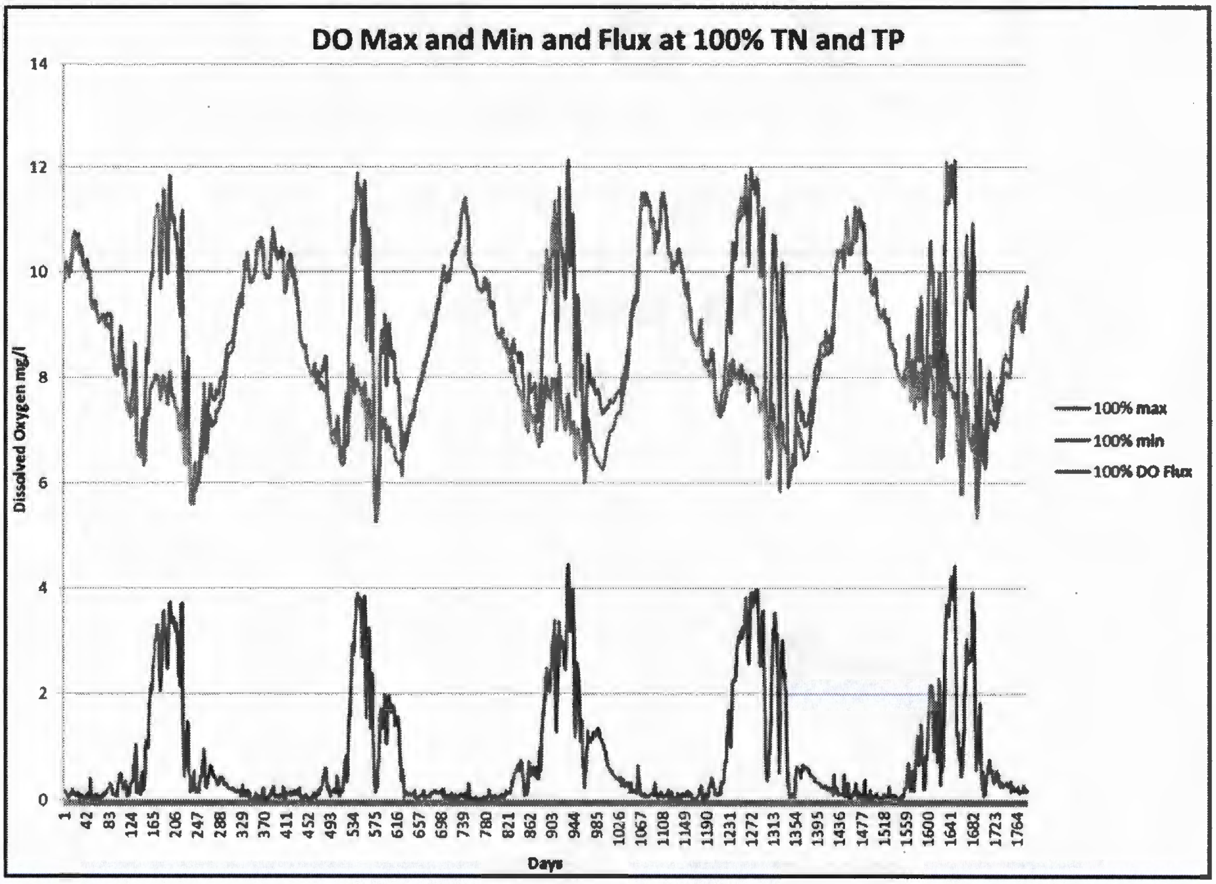


Figure 24 DO Flux at 100% TN and TP

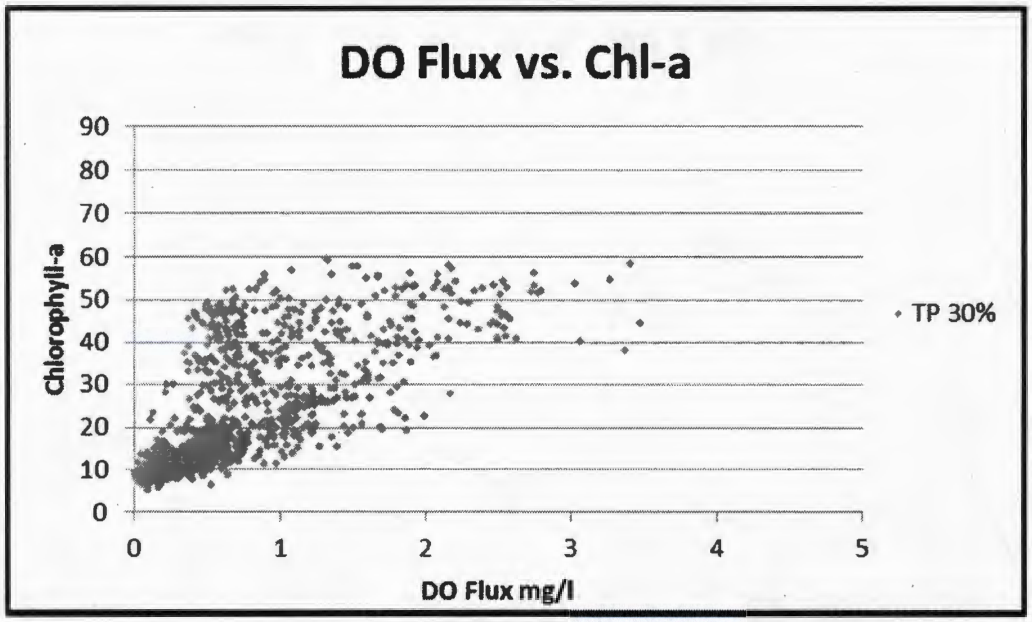


Figure 27 DO Flux vs. Chl-a TP 30%

Figures 24 and 25 show the maximum and minimum DO as well as the DO flux for the model output for the 100% and 30% TP available models. Figures 26 and 27 show the relationship of DO flux to chlorophyll-a for both models. The DO flux maximum value dropped from 4.45 to 3.47. The average DO flux dropped from 0.79 to 0.48. The chlorophyll-a maximum dropped from 76.9 to 59.5 μg/l.

3.4 TMDL Target Selection

Several pathways were considered for development of the TMDL target both in the causal and in the response variables. Model output shows a 70% reduction in TP provides a chlorophyll-a maximum below 60 μg/l and a 90th percentile maximum of 41.7 μg/l. The seasonal geometric mean for the average year of 2008 was 23 μg/l. The DO flux was below 3.5 mg/l. This 70% reduction of TP is an aggressive reduction goal. The existing 2009 TMDL sets the reduction target to 56%. Modeling indicates there will be an improvement to water quality as a response to this reduction target.

The 70% TP reduction target is an overall reduction for total (point and nonpoint) load within the WASP model. The next chapter will discuss the allocation of the LA and WLA to the point and non-point sources in the watershed.

Figure 28 shows model results for TP for the calibrated model and the 2009 and 2014 TMDL reduction targets.

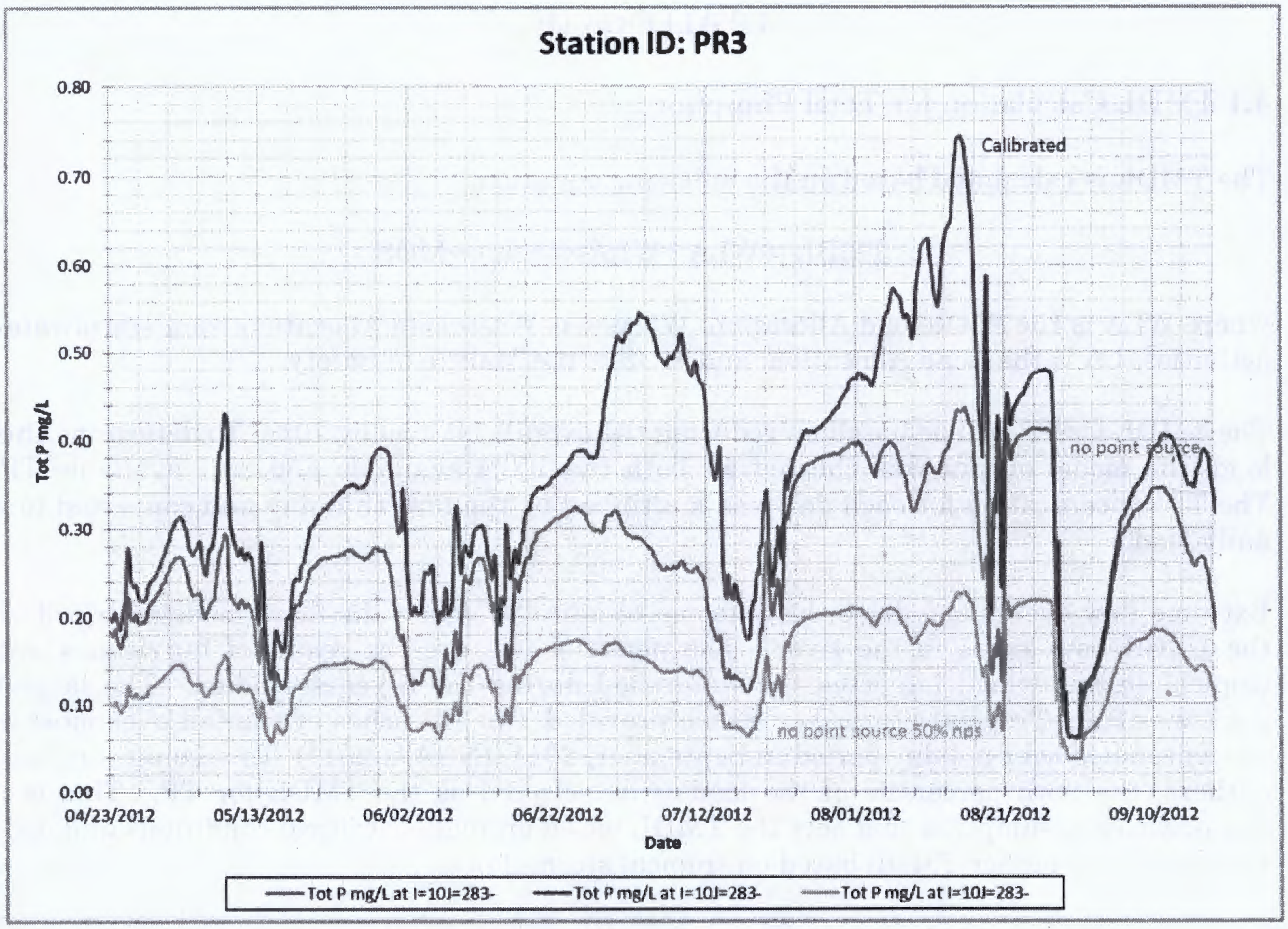


Figure 29 Model Output of TP with and without point sources

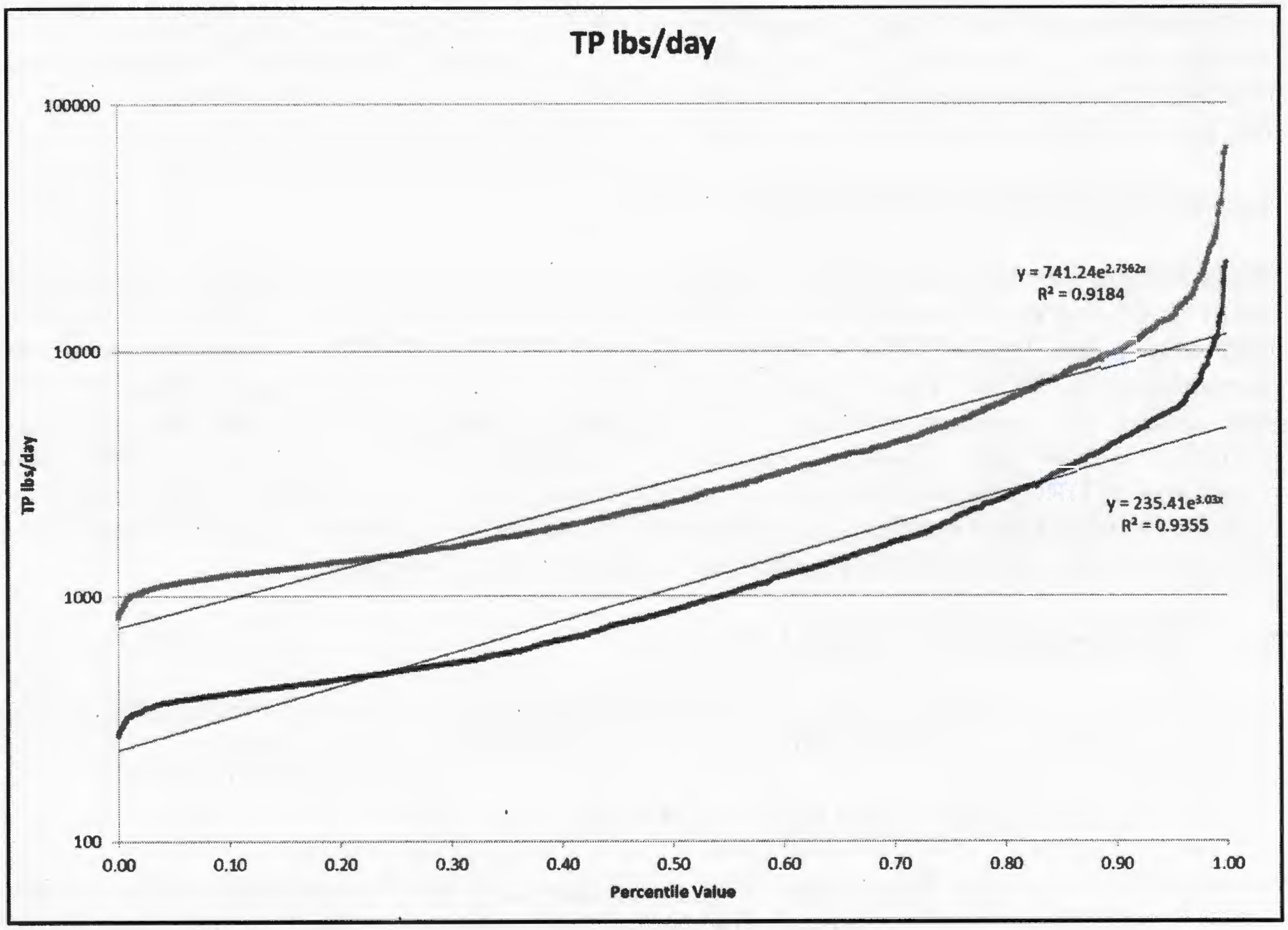


Figure 31 TP Load Regression

4.2 Waste Load Allocation

This model provided for the direct calculation of the TP TMDL at 4,208 lbs. per day during the growing season. This TMDL value must be allocated between point and non-point sources. To achieve this allocation, the TMDL will be divided between the WLA and LA portions. The LA portion will also be allocated between non-point source load and WLAsw to determine the overall allocations for the TMDL. See Table 9 below for the calculations.

4.2.1 City of Jackson POTW - Savanna Street Facility

The City of Jackson POTW, Savanna Street Facility, had seasonal flow limits of 46 MGD in the summer (May – October) and 120 MGD in the winter (November – April) in the previous NPDES permit. This permitted flow was changed to match the technical capacity of the treatment plant at 46 MGD year round at the last permit reissuance. The average flow of this facility, taken from their NPDES permit application based on 777 samples, is 48.14 MGD. This figure was used in the calibration modeling; however, 46

4.3 Wasteload Allocation Storm Water

MDEQ has established a method to estimate the storm water waste load allocation (WLAsw). The WLAsw is calculated according to the equation below. The intent of the storm water NPDES permit is not to treat the water after collection, but to reduce the exposure of storm water runoff to pollutants by implementing various controls. Storm water NPDES permits require the establishment of controls or BMPs to reduce the pollutants entering the environment.

Waste Load Allocation Storm Water (WLAsw) = LA * % Urban Area in MS4 within watershed * 70%

WLAsw = LA * 27.2% * 70% = 19.04% * LA to proportion the Stormwater WLA

WLAsw = 2,000 lbs. per day * 27.2% * 70% = 381 lbs. per day

4.4 Load Allocation

This TMDL recommends a nonpoint source reduction of TN and TP. Best management practices should be encouraged in the watersheds to reduce potential TN and TP loads from non-point sources.

For land disturbing activities related to silviculture, construction, and agriculture, it is recommended that practices, as outlined in "Mississippi's BMPs: Best Management Practices for Forestry in Mississippi" (MFC, 2008), "NPS Field Manual For Erosion And Sediment Control Version 2." (MDEQ, et. al, 2011), and "Field Office Technical Guide" (NRCS, 2012), be followed, respectively.

Figure 32 below shows the existing BMPs in the watershed presently.

4.5 Incorporation of a Margin of Safety

The margin of safety is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving water body. The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this model is implicit.

4.6 TP TMDL Allocations

Table 12 shows the WLA, WLAsw, and LA allocations for TP in the segment. These are specific to the results of the modeling at cell 360 near Hopewell and are based on the critical conditions found in the model output. The *de minimis* point sources are grouped into one listing.

Table 12 TP TMDL Allocations

Facility	AI No.	Discharge (MGD)	TP Concentration (mg/l)	TP Load (lbs./day)
City of Jackson POTW- Savanna Street	13201	46	2.95	1131.7
Future growth	56736	20	2.52	439.3
City of Jackson POTW- Trahon	13203	4.5	2.95	110.7
O.B. Curtis Water Treatment Plant	4369	3.12	2.95	76.8
City of Florence POTW	13136	0.5	5.6	23.4
City of Terry POTW	13414	0.12	5.6	5.6
City of Georgetown POTW	13147	0.11	5.6	5.1
Red River Utility Company	14062	0.1144	5.2	5.0
Cleary Heights S/D	13066	0.1	5.6	4.7
Rowan Oaks S/D	16342	0.088	5.6	4.1
Other de minimis Facilities		0.442	5.6	20.1
WLAsw				381.0
Load Allocation				2000.0
Total TMDL				**4,207.5**

TN Allocation

5.1 TMDL Established for Nitrogen

The TMDL for TN was established in the same manner as in TP. The model output for the 30%TP available run was used to establish the TN TMDL. Again the 90th percentile value was used to provide a conservative value for TN based on avoiding tropical storm flows.

The 90th percentile of TN in pounds per day in the 30%TP available model run is 75,733 pounds per day. This TMDL proposes to set the TN concentration in point source permits at 13.6 to 11.5 mg/l based on literature values of adequate WWTP TN treatment. The goal of the TMDL is to achieve water quality restoration through limiting TP. However, the same BMPs that will control the TP contribution from nonpoint sources will also control TN from that source.

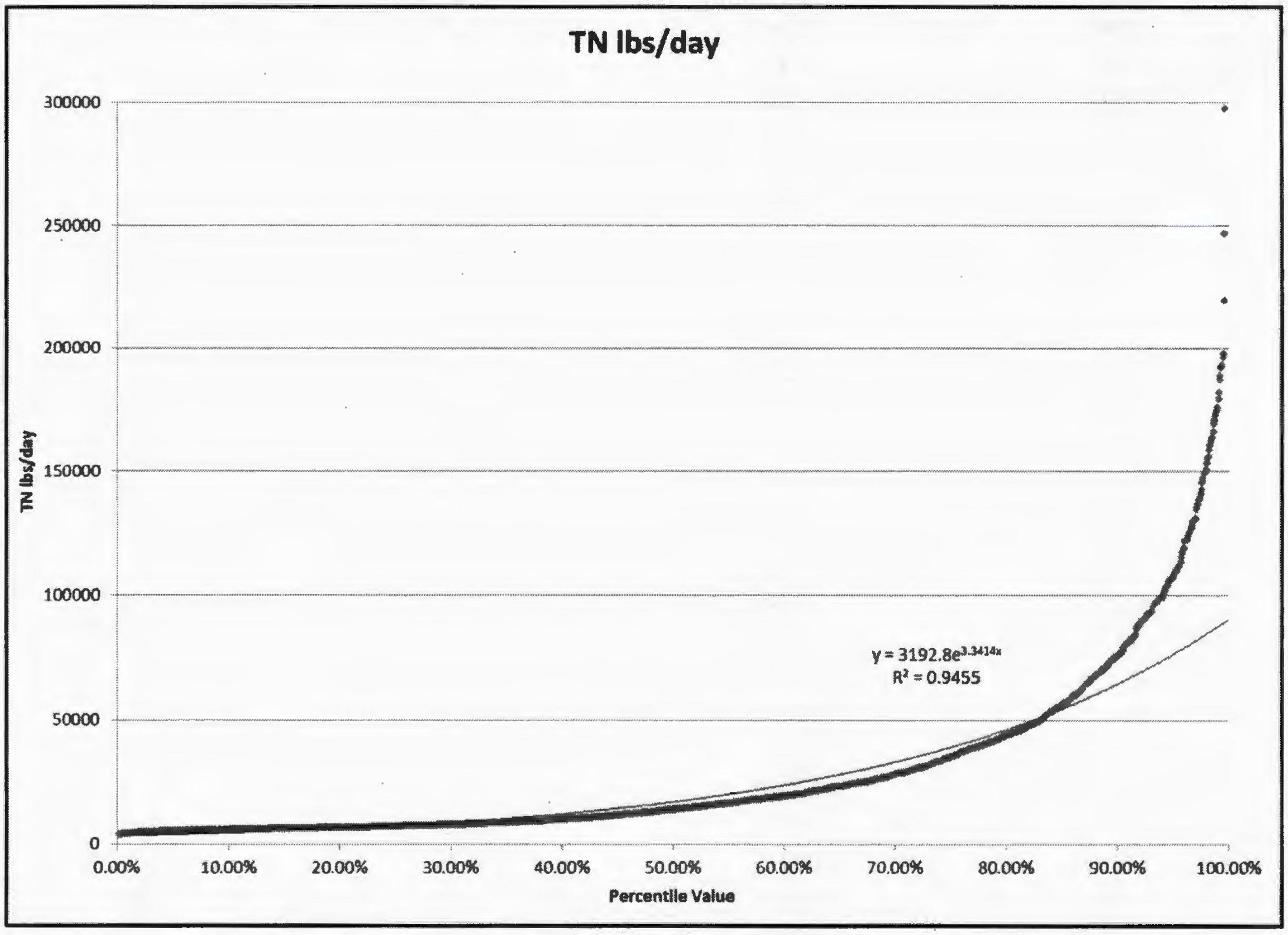


Figure 34 TN Pounds per Day Regression

13844	0.001	11.5	0.1
13998	0.001	11.5	0.1
14076	0.001	11.5	0.1
14253	0.001	11.5	0.1
18762	0.0006	11.5	0.1
16033	0.0005	11.5	0.0
16316	0.0005	11.5	0.0
70	0.00043	11.5	0.0
13961	0.0004	11.5	0.0
12162	0.00004	11.5	0.0
14327	0.012	11.5	1.2
1451	0	11.5	0.0
14812	0	11.5	0.0
Total	**76.5**		**8828.4**

5.3 Wasteload Allocation Storm Water

The same stormwater calculation used for TP has been applied to TN.

Waste Load Allocation Storm Water (WLAsw) = LA * % Urban Area in MS4 within watershed * 70%

WLAsw = LA * 27.2% * 70% = 19.04% * LA to proportion the Stormwater WLA

WLAsw = 54,602 lbs. per day * 27.2% * 70% = 10,396 lbs. per day

5.4 Load Allocation and Margin of Safety

These loads are also constructed as in the TP TMDL. There is sufficient assimilative capacity in TN such that reduction is not required by this TMDL.

CONCLUSION

The implementation of BMP activities should continue to reduce the nutrient loads entering the Pearl River. The limiting of TN and TP from the waste water treatment plants and the restoration of the Savanna St. POTW will also provide for improved water quality from the point sources. This will provide improved water quality for the support of aquatic life in the water bodies, and will result in the attainment of the applicable water quality standards.

6.1 Next Steps

MDEQ's Basin Management Approach and Nonpoint Source Program emphasize restoration of impaired waters with developed TMDLs. During the watershed prioritization process to be conducted by the Pearl River Basin Team, this TMDL will be considered as a basis for implementing possible restoration projects. The Pearl River and the Ross Barnett Reservoir are both actively receiving coverage in basin management projects. The basin team is made up of state and federal resource agencies and stakeholder organizations and provides the opportunity for these entities to work with local stakeholders to achieve quantifiable improvements in water quality. Together, basin team members work to understand water quality conditions, determine causes and sources of problems, prioritize watersheds for potential water quality restoration and protection activities, and identify collaboration and leveraging opportunities. The Basin Management Approach and the Nonpoint Source Program work together to facilitate and support these activities.

The Nonpoint Source Program provides financial incentives to eligible parties to implement appropriate restoration and protection projects through the Clean Water Act's Section 319 Nonpoint Source (NPS) Grant Program. This program makes available around $1.6M each grant year for restoration and protections efforts by providing a 60% cost share for eligible projects.

Mississippi Soil and Water Conservation Commission (MSWCC) is the lead agency responsible for abatement of agricultural NPS pollution through training, promotion, and installation of BMPs on agricultural lands. USDA Natural Resource Conservation Service (NRCS) provides technical assistance to MSWCC through its conservation districts located in each county. NRCS assists animal producers in developing nutrient management plans and grazing management plans. MDEQ, MSWCC, NRCS, and other governmental and nongovernmental organizations work closely together to reduce agricultural runoff through the Section 319 NPS Program.

Mississippi Forestry Commission (MFC), in cooperation with the Mississippi Forestry Association (MFA) and Mississippi State University (MSU), has taken a leadership role in the development and promotion of the forestry industry Best Management Practices (BMPs) in Mississippi. MDEQ is designated as the lead agency for implementing an

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1.0 INTRODUCTION

1.1 Objectives

The Office of Pollution Control (OPC), Mississippi Department of Environmental Quality (MDEQ), has concerns about nutrient enrichment of the Pearl River. Through the nutrient criteria development process, MDEQ is evaluating how to establish nutrient criteria for large rivers. One option, expressed by MDEQ, is to use a calibrated water quality model as a tool for evaluating nutrient and Biochemical Oxygen Demand (BOD) impacts on key water quality variables, such as dissolved oxygen (DO) and/or chlorophyll (Chl a).

The Georgia-Pacific Monticello LLC (GP) Mill, located near Monticello, Mississippi, has an interest in the Pearl River and how the future nutrient criteria may impact the mill. To assist MDEQ in this process, GP Monticello contracted development of a Pearl River calibrated water quality model that can be used for TMDL development as a tool for developing nutrient criteria. GP Monticello is providing this model to MDEQ for their use. This report documents the calibration and development of the Pearl River hydrodynamic and water quality model. Initially the model was only going to cover the Pearl River from Monticello to Columbia, but with assistance and data provided by MDEQ the Pearl River model extends from Jackson, Ms. to Bogalusa, La. The Pearl River model includes water quality parameters and kinetics that can assess both BOD/DO impacts and Chl a/nutrient impacts on the river. The time period for this model is 2008 – 2012, which includes the 2008 critical summer low flow high temperature period for evaluating the BOD/DO impacts and a range of summer flow conditions for evaluating nutrient/Chl a impacts.

1.2 Study Area Description

The Pearl River model starts below Ross Barnett Reservoir near Jackson, Mississippi and extends past Monticello to the City of Bogalusa along the Mississippi and Louisiana border. The river then continues downstream to the Mississippi Gulf Coast.

The GP Mill is located adjacent to the Pearl River near Monticello, Mississippi. The Mill is a containerboard facility producing Kraft linerboard that is used to make the strong outer and inner layer of corrugated containers. Effluent from the Mill is treated via primary and secondary treatment systems before being released into the Pearl River.

1.3 Summary

The hydrodynamic model Environmental Fluid Dynamics Code (EFDC) was selected to simulate hydrodynamics, temperature, and transport processes for this study. The Pearl River EFDC model was used to simulate the flow and temperature for the Pearl River Study Area. A one dimensional grid was setup from 2000 through 2012. The EFDC hydrodynamic simulation is used to drive the Water Quality Analysis Simulation Program (WASP) Version 6.5 water quality model. The WASP model was operated on the same one dimensional grid used for the EFDC. For the water quality model calibration, the five-

USGS Gage #	Location	Parameter	Units	Mean	Min	Max
2486000	Jackson	Flow	cfs	3696	148	49800
2488000	Rockport	Flow	cfs	6803	375	61000
2488500	Monticello	Flow	cfs	6047	438	62800
2489000	Columbia	Flow	cfs	6922	799	64400
2489500	Bogalusa	Flow	cfs	9116	1140	76800

Table 14 USGS Pearl River Gages and Flow Rates (cubic feet per second (cfs))

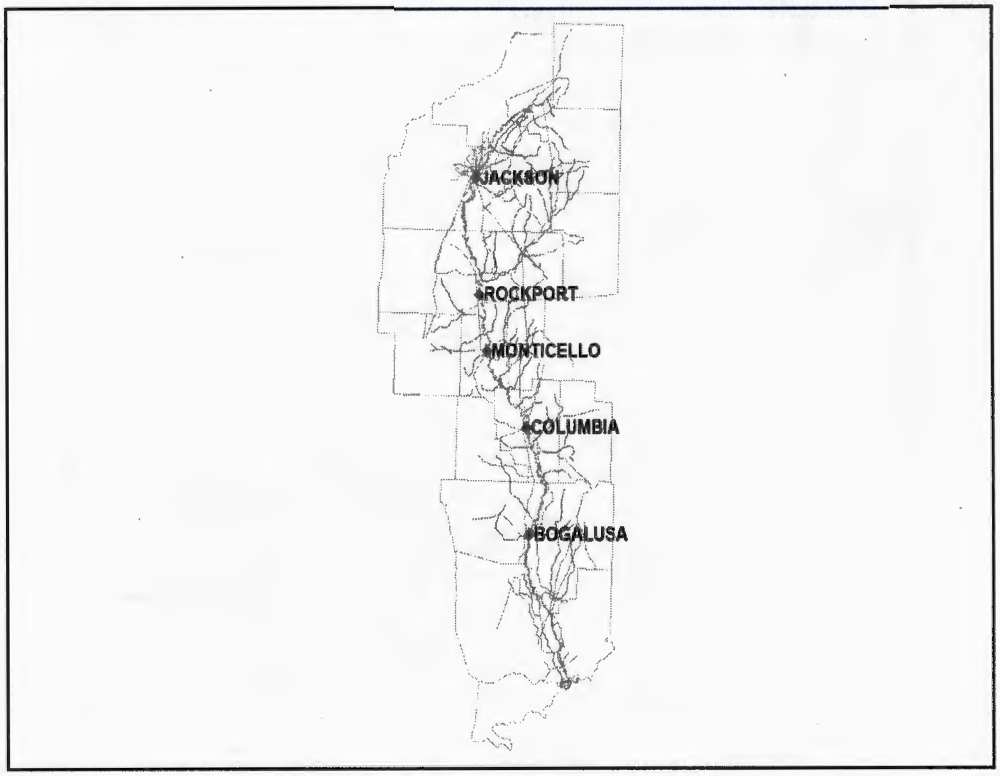

Figure 36 Pearl River USGS Gages

2.2 MDEQ and EPA Water Quality Studies

2.2.1 EPA and MDEQs' 2012 Pearl River Intensive Water Quality Study

EPA and MDEQ collected water quality data for the Pearl River and tributaries August 30 to September 1, 2012 (EPA 2012). The Pearl River section started at Moncure Road and ended below Rockport Road. The study included sampling locations at 8 sites on the Pearl River (PR1 – PR9) and four tributary stations (SR1, BC1 and CC1); station details are listed in the EPA report. See Figure 2 for map of the study area and sampling locations. Data collection included:

Table 15 DO and Temperature Summary, August 30 – September 1, 2012 Study

Station	Parameter Name	Units	Mean	Min	Max
PR1	Dissolved oxygen	mg/l	8.97	6.00	11.93
PR2	Dissolved oxygen	mg/l	9.05	6.62	12.14
PR3	Dissolved oxygen	mg/l	9.95	7.25	12.80
PR4	Dissolved oxygen	mg/l	9.54	7.57	11.95
PR5	Dissolved oxygen	mg/l	9.41	7.27	11.30
PR6	Dissolved oxygen	mg/l	9.07	6.53	11.62
PR7	Dissolved oxygen	mg/l	9.21	7.02	11.93
PR8	Dissolved oxygen	mg/l	9.60	7.11	13.01
PR1	Temperature, water	deg C	33.21	31.73	34.52
PR2	Temperature, water	deg C	33.28	31.55	35.18
PR3	Temperature, water	deg C	33.26	32.23	34.74
PR4	Temperature, water	deg C	33.18	32.56	33.86
PR5	Temperature, water	deg C	32.91	32.23	33.60
PR6	Temperature, water	deg C	32.57	31.70	33.21
PR7	Temperature, water	deg C	32.51	31.55	34.00
PR8	Temperature, water	deg C	32.55	31.42	33.93

mg/l – milligrams per liter, deg C – degrees Celsius

2.2.2 MDEQ September 2010 Study

MDEQ, in September 2010, collected *insitu* WQ data, chemical WQ data and long-term biochemical oxygen demand (BOD) data in the Pearl River near Monticello (MDEQ 2010). The sampling locations included four Pearl River Stations (PR1 – PR4), GP Mill Effluent (GP) and Hall Creek (HC1-HC3). Figure 3 shows the study area and sampling stations.

Table 16 Nutrient Sampling - Pearl River at Byram at Old Swinging Bridge

Parameter Name	Units	No. Obs.	Mean	Min	Max
Ammonia as NH3	mg/l	57	0.19	0.04	1.28
Nitrate-Nitrite	mg/l	63	0.59	0.07	2.12
Orthophosphate	mg/l	1	0.1	0.1	0.1
Kjeldahl nitrogen	mg/l	62	0.96	0.12	2.1
Total Nitrogen	mg/l	48	1.5	0.49	3.23
Organic Phosphorous	mg/l	1	0.05	0.05	0.05
Phosphorus	mg/l	63	0.27	0.05	1.12

mg/l – milligrams per liter

2.2.4 MDEQ Pearl River April and May 2008 Special TMDL Nutrient Study

In April and May 2008, MDEQ collected Chl a and nutrient data at the seven monitoring stations shown in Figure 4. This provided the most comprehensive snapshot of the distribution of nutrients and Chl a throughout the Pearl River system. This data are summarized in Tables 4 - 6.

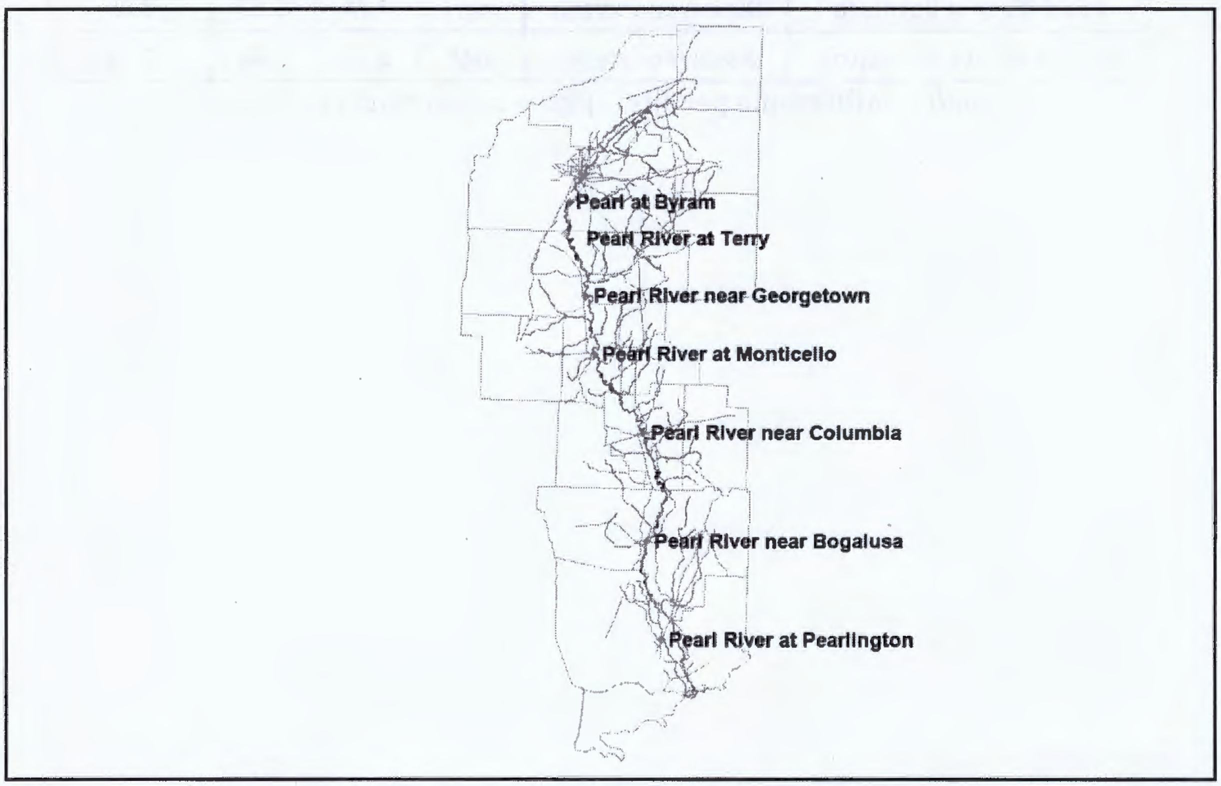

Figure 39 MDEQ 2008 TMDL Study Sampling Stations

Table 18 MDEQ 2008 Nitrogen Series Data

Station Name	Parameter Name	Units	Mean	Min	Max
Pearl River at Byram	Ammonia	mg/l	0.09	0.04	0.13
Pearl River near Terry	Ammonia	mg/l	0.14	0.04	0.23
Pearl River at Georgetown	Ammonia	mg/l	0.04	0.04	0.04
Pearl River near Monticello	Ammonia	mg/l	0.04	0.04	0.04
Pearl River at Columbia	Ammonia	mg/l	0.04	0.04	0.04
Pearl River at Pearlington	Ammonia	mg/l	0.14	0.04	0.19
Station Name	**Parameter Name**	**Units**	**Mean**	**Min**	**Max**
Pearl River at Byram	Nitrate-Nitrite	mg/l	0.26	0.19	0.33
Pearl River near Terry	Nitrate-Nitrite	mg/l	0.4	0.17	0.72
Pearl River at Georgetown	Nitrate-Nitrite	mg/l	0.25	0.15	0.35
Pearl River near Monticello	Nitrate-Nitrite	mg/l	0.27	0.17	0.37
Pearl River at Columbia	Nitrate-Nitrite	mg/l	0.37	0.34	0.4
Pearl River at Pearlington	Nitrate-Nitrite	mg/l	0.16	0.14	0.17
Station Name	**Parameter Name**	**Units**	**Mean**	**Min**	**Max**
Pearl River at Byram	TKN	mg/l	0.96	0.87	1.14
Pearl River near Terry	TKN	mg/l	1.02	0.73	1.38
Pearl River at Georgetown	TKN	mg/l	1.24	1.2	1.28
Pearl River near Monticello	TKN	mg/l	1.4	1.39	1.41
Pearl River at Columbia	TKN	mg/l	0.99	0.84	1.13
Pearl River at Bogalusa	TKN	mg/l	1.01	1	1.02
Pearl River at Pearlington	TKN	mg/l	0.8	0.79	0.81
Station Name	**Parameter Name**	**Units**	**Mean**	**Min**	**Max**
Pearl River at Byram	Total Nitrogen	mg/l	1.22	1.06	1.47
Pearl River near Terry	Total Nitrogen	mg/l	1.47	1.44	1.55
Pearl River at Georgetown	Total Nitrogen	mg/l	1.49	1.43	1.55
Pearl River near Monticello	Total Nitrogen	mg/l	1.67	1.58	1.76
Pearl River at Columbia	Total Nitrogen	mg/l	1.36	1.18	1.53
Pearl River at Bogalusa	Total Nitrogen	mg/l	1.21	1.11	1.31
Pearl River at Pearlington	Total Nitrogen	mg/l	0.96	0.95	0.96

mg/l – milligrams per liter, µg/l – micrograms per liter

Table 20 GP Monticello Efflunet Data

Parameter	Units	Mean	Min	Max
FLOW	mgd	28.1	0.0	50.8
BOD5	mg/l	42.1	0.0	106.0
Ammonia	mg/l	1.7	0.0	9.0
Ntrate-Nitrite	mg/l	0.1	0.1	0.1
Organic Nitrogen	mg/l	9.5	9.5	9.5
Phosphate	mg/l	0.1	0.0	2.2
Total Phosphorus	mg/l	1.3	0.4	3.6

mgd – million gallons per day, mg/l – milligrams per liter

2.3.2 GP Monticello Pearl River Sampling

GP Monticello routinely collects Pearl River water quality data both upstream and downstream of their effluent discharge. Table 8 summarizes these data.

Table 21 GP Monticello River Sampling Data

Station Name	Parameter Name	Units	No. Obs.	Mean	Min	Max
Pearl River Upstream GP Monticello	BOD5	mg/l	4243	2.42	0.5	8
Pearl River Upstream GP Monticello	DO	mg/l	4256	8.64	5	12
Pearl River Upstream GP Monticello	Temperature, water	deg C	4259	19.99	6	32
Pearl River Downstream of GP Monticello	BOD5	mg/l	4247	3.02	0.5	9.5
Pearl River Downstream of GP Monticello	DO	mg/l	4254	7.4	5	14

BOD5 – 5-day biochemical oxygen demand, DO – dissolved oxygen, mg/l – milligrams per liter, deg C – degrees Celsius

2.3.3 GP Monticello Contracted Reaeration Study

GP Monticello contracted with HYDRO2 consultants to measure the reaeration in the Pearl River below their discharge site providing a more scientifically defensible value. The river reach of interest extends from the point of discharge downstream to below the city of Monticello, Mississippi. The measured reaeration rates ranged from 1.16 to 1.62 (grams oxygen/meter^2/day).

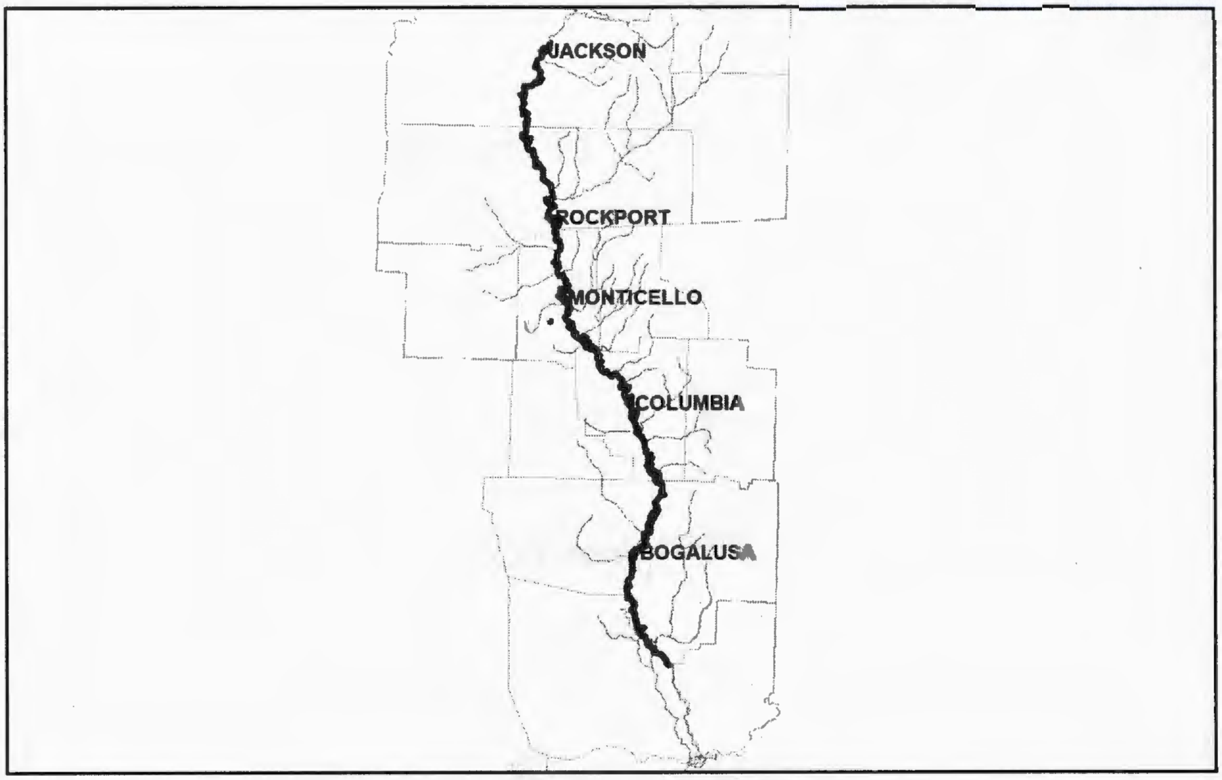

Figure 40 Pearl River Model Grid Full Extent

3.1 Flows

The USGS Highway 80 Jackson gage flow was used as the headwater boundary flow for the Pearl River model. The tributary and groundwater inflows between the USGS gages were estimated using the difference of flow between the gages (for example USGS Monticello gage flows minus USGS Jackson gage flows). This difference in flow was distributed to the tributary and ground water flow inputs. The groundwater was estimated to be a total of 100 cubic feet per second (cfs) distributed 10 cfs every 10 kilometers. The remaining delta flow was distributed between the major tributaries proportional to their drainage area size. The measured GP Monticello water withdrawal and effluent discharge was also included in the model.

Table 9 shows the magnitude and R-squared correlation coefficient of flows at the USGS gages and Figures 7 through 11 illustrate the time series comparison between measured and simulated flows. For Figure 8 (USGS Gage at Rockport Road) only a partial flow record was available, the gage was out of use in 2002 and discontinued in 2004.

Table 22 EFDC Flow Calibration Statistics

Station	Measured Flow (cfs)			Simulated Flow (cfs)			Correlation Coefficeint
	Mean	5 Percentile	95 Percentile	Mean	5 Percentile	95 Percentile	
Jackson	3689	15700	216	3729	15717	219	0.99
Rockport	6809	25860	425	6976	27689	416	0.93
Monticello	6033	24600	549	6053	24192	549	0.93
Columbia	6907	25700	986	7175	26659	1050	0.91
Bogalusa	9098	35200	1510	9658	35973	1616	0.95

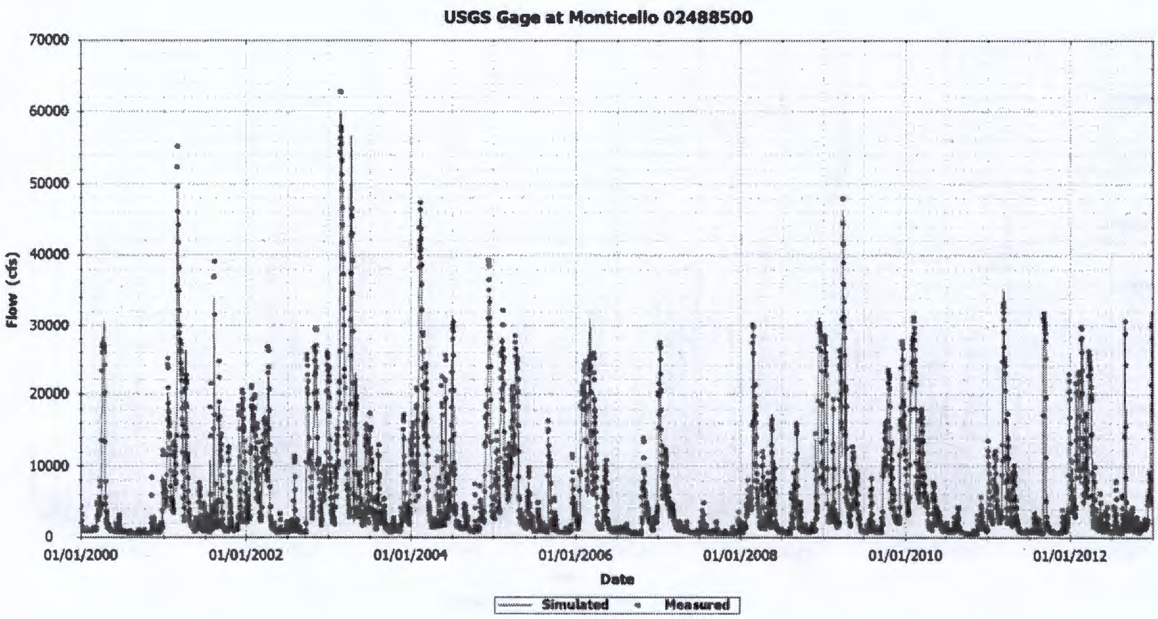

Figure 44 Simulated and Measured Flows – USGS Gage at Monticello

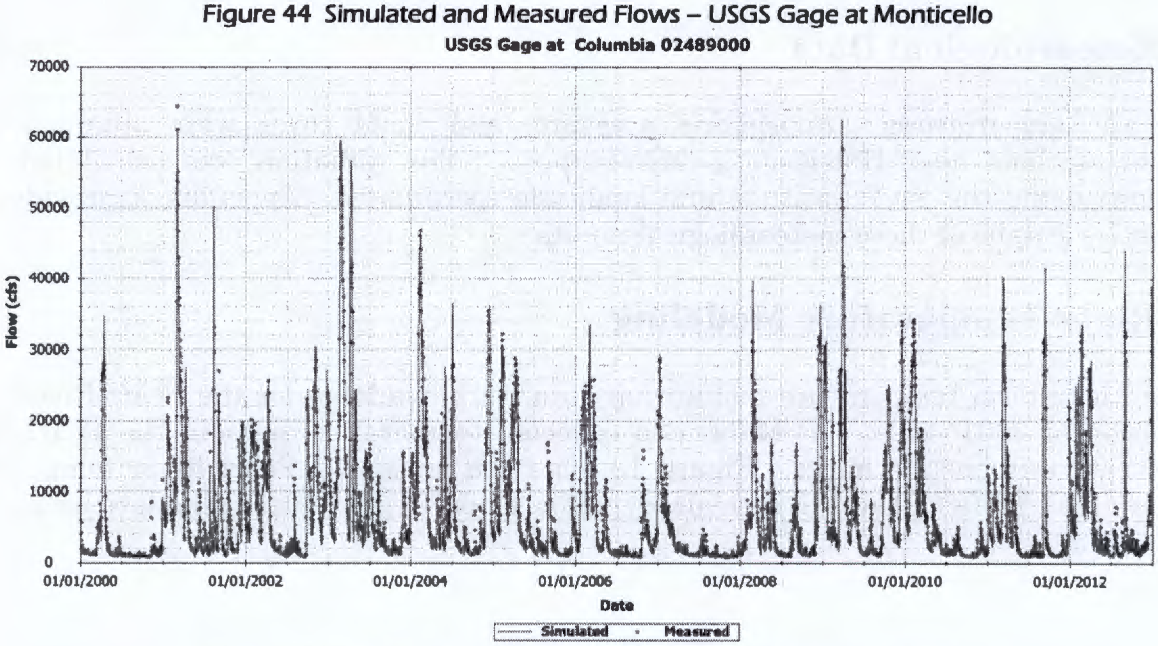

Figure 45 Simulated and Measured Flows – USGS Gage at Columbia

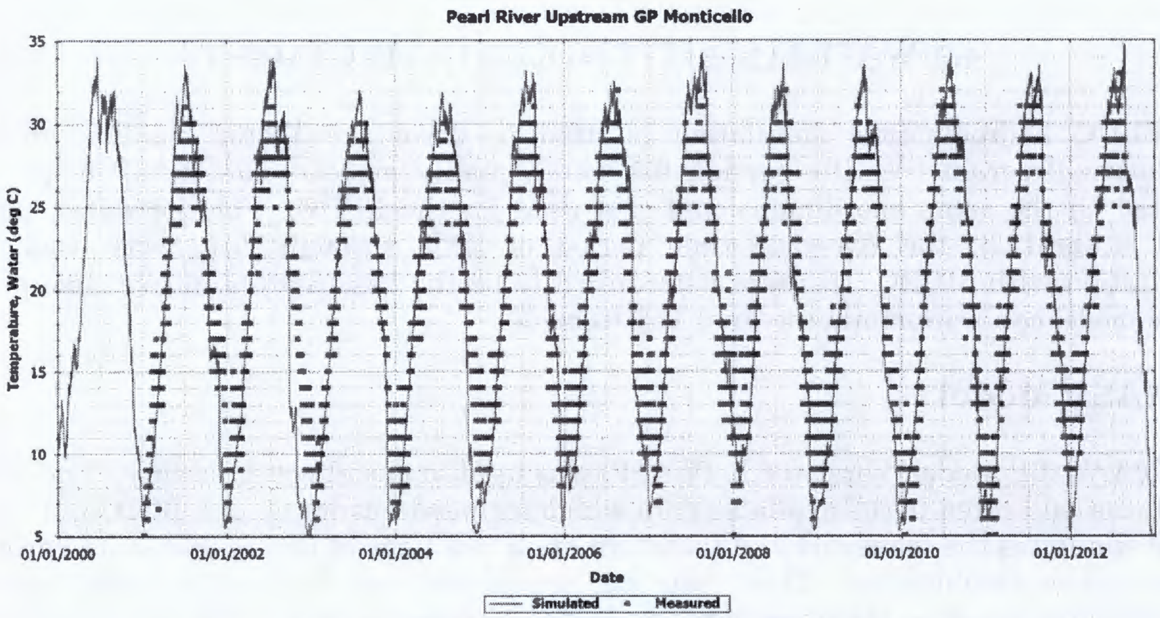

Figure 47 Pearl River Temperature Upstream GP Effluent Discharge

Tributary inflow temperatures had to be estimated since no long term temperature data are available for the tributaries. Tributary temperatures were estimated by fitting a sine curve to the measured values from a variety of temperature sampling sites in nearby watersheds. The temperature sine curve represents the seasonal change in temperature throughout the year. The resultant estimated temperature time series is shown in Figure 13, with temperatures ranging from 8 to 28 degrees Celsius.

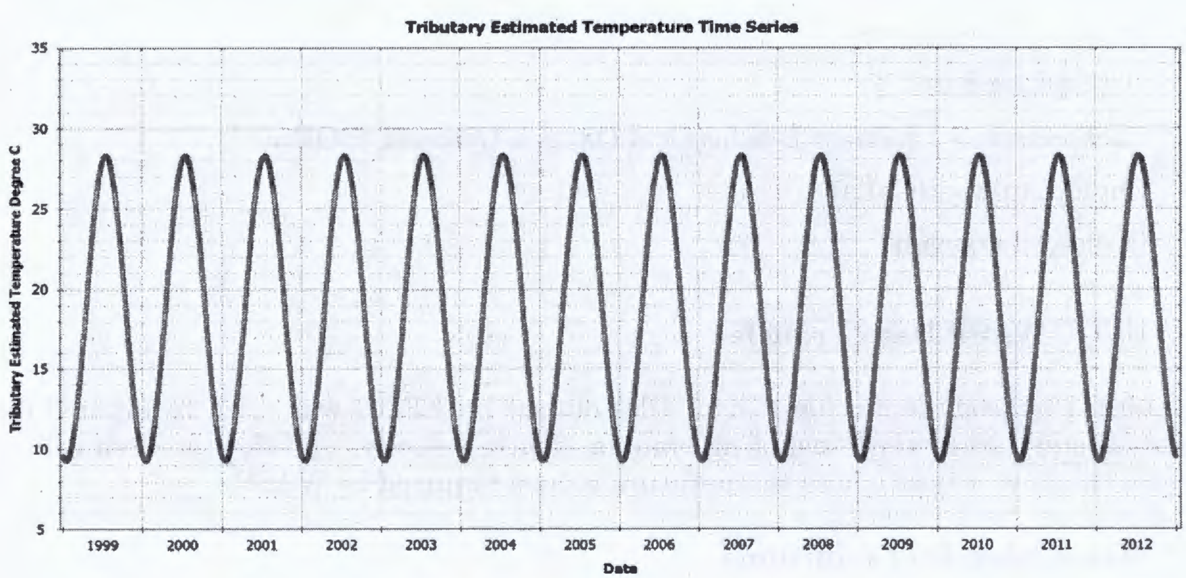

Figure 48 Tributary Temperatures

The groundwater temperature was input as a constant 12 degrees C.

4.1.3 Light Extinction

WASP models the light available for photosynthesis from the incident solar radiation at the water surface and the rate of light attenuation or "extinction" in the water column. Light extinction is represented by an extinction coefficient (*Ke*), such that light remaining at depth *z* is equal to:

$$I_0 * e^{-Ke \cdot z},$$

where I_0 is the light penetration at the surface. Using the depth of the water, the average *Ke* value can be calculated and used in the WASP model.

The model estimates *Ke* as the combined effects of algal self-shading, which can be important under bloom conditions, and a non-algal component, represented through a user-supplied extinction coefficient. Light extinction coefficient estimations were obtained from the 2012 EPA and MDEQ water quality study. Water column *Ke* values ranged from 2 to 3.5 per meter. Basically, the light penetrated trough the water column and reached the bottom.

4.1.4 Sediment Oxygen Demand

The decomposition of organic material in bottom sediment can lower the concentrations of oxygen in the overlying waters. The decomposition of organic material results in the exertion of an oxygen demand at the sediment-water interface called sediment oxygen demand (SOD). Measured Pearl River SOD values during the 2012 study ranged from 0.8 to 1.3 grams oxygen/meter^2/day, measured rates adjusted to 20 degrees C.

4.1.5 Reaeration

Two reaeration studies were conducted on different stretches of the Pearl River. In 2011, GP Monticello contracted with HYDRO2 to conduct a reaeration study for the Pearl River around Monticello (2011 HYDRO2). The reaeration rates ranged from 0.8 to 1.3 grams oxygen/meter^2/day. In 2012, EPA conducted a reaeration study on the Pearl River around Rockport. The reaeration rates ranged from 0.4 to 2.0 grams oxygen/meter^2/day. WASP can use either reaeration input directly or various reaeration formulations that varies reaeration with change of river's velocity and depth. The WASP model's O'Connor Dobbins reaeration formulation was used as the O'Connor Dobbins reaeration formulation represented the actual reaeration measurements for the time periods they were selected.

For the Pearl River below GP Monticello the measured reaeration rate (August 29 – 31, 2011, was 1.62 grams oxygen/meter^2/day. Figure 14 illustrates the simulated reaeration rate for the Pearl River below GP Monticello and Figure 15 compares the measured and simulated reaeration rates for August 29 – 31, 2012.

4.1.6 BOD, Nutrient, and Algal Rates and Kinetics

Normal rate and kinetic values as modeled in other southeast water quality models were used as the starting values for the Pearl River model. However the BOD decay rate, BOD ultimate to BOD_5 ratio, the algal growth rate, and the carbon to Chl a ratio were adjusted based on the available data. These rates and kinetic values are provided in Appendix B.

The MDEQ long-term BOD measurements provide an *f ratio* (ultimate carbonaceous BOD (BODuc) to BOD_5 day ratio) range of 3 to 3.7. The Pearl River WASP model used an average ratio of 3.5 for all the BOD inputs and a river BODuc decay rate of 0.07 per day. The exception was the GP Monticello effluent, where a *f ratio* (BODuc to BOD_5 ratio) of 7.0 was used based on the long-term BOD data.

The algal growth rates and algal carbon to Chl a ratio was adjusted to match the available Chl a measurements and the measured diurnal DO. An algal growth rate of 1.5 per day and carbon to Chl a ratio of 100 were used as the final values.

4.1.7 Wastewater Discharges

There are seven (7) major wastewater discharges (five publicly owned treatment facilities (POTW) discharges and two industrial discharges) included in the Pearl River WASP Model. These are:

- GP Monticello Industrial
- Savannah Street, City of Jackson POTW
- Trahon, City of Jackson POTW
- Monticello POTW
- Copiah POTW
- Columbia POTW
- Sanderson Farms WWTP
- Hazlehurst POTW

GP Monticello effluent discharge parameters were based on available data and were summarized in Section 2.3.1. To illustrate the variation in the GP Monticello effluent data, Figures 16 – 19 show the actual flow, BOD5, nitrogen series, and phosphorous series time-series used in the WASP model.

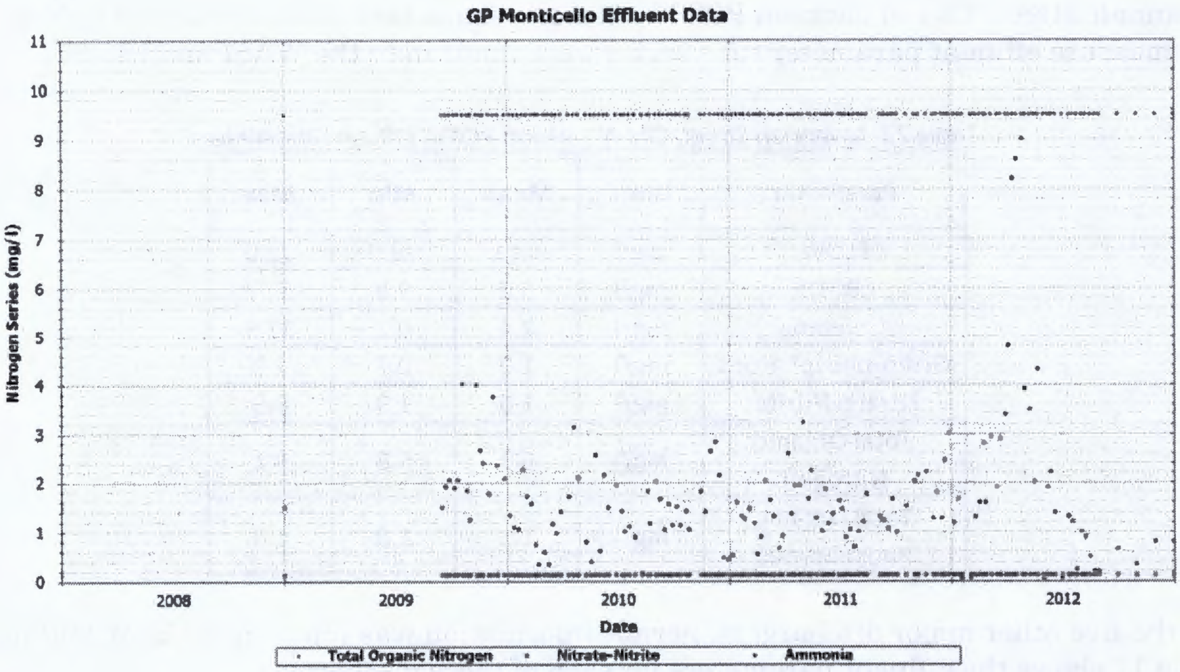

Figure 53 GP Monticello Effluent Discharge Nitrogen Series Data

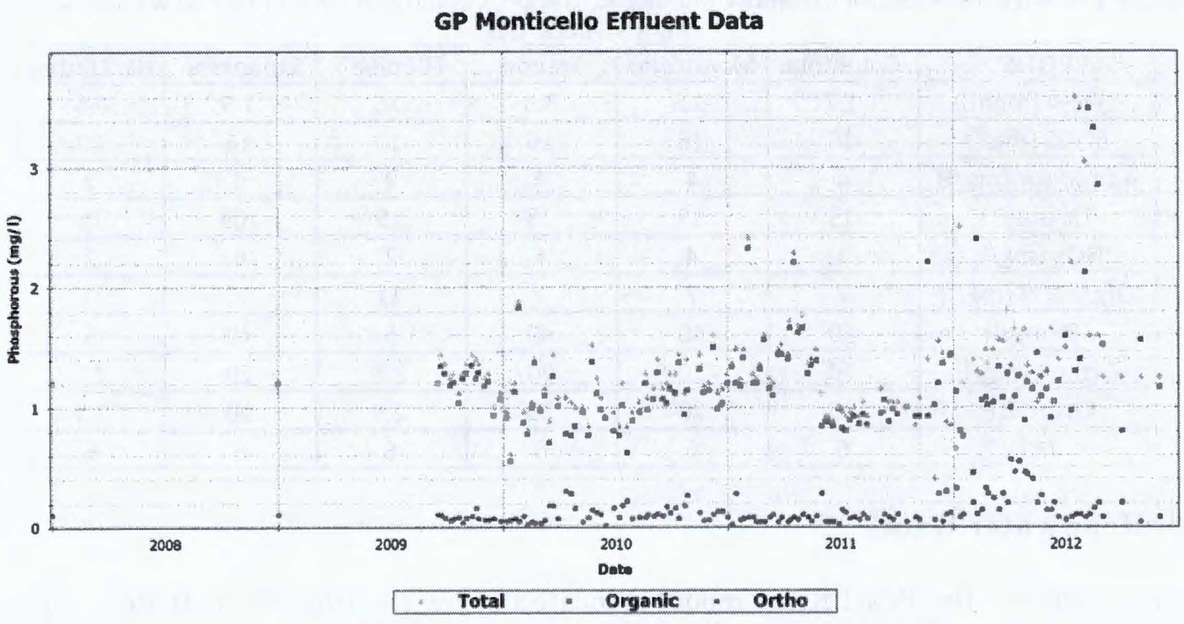

Figure 54 GP Monticello Effluent Discharge Phosphorous Series Data

overflows added measurable nitrogen loadings to the Pearl River. For modeling purposes the estimated additional nitrogen was include in the headwater Nitrate-Nitrite time series. For the TMDL model the nitrate-nitrite time series will be returned to its normal time pattern that was measured during 2008 -2009.

Figure 20 illustrates both the nitrate-nitrite time series used for the calibrated model and the expected normal time series used in the TMDL model. Figures 21 to 25 illustrate the data time series for other nitrogen, phosphorous, BOD5, and DO headwater parameters.

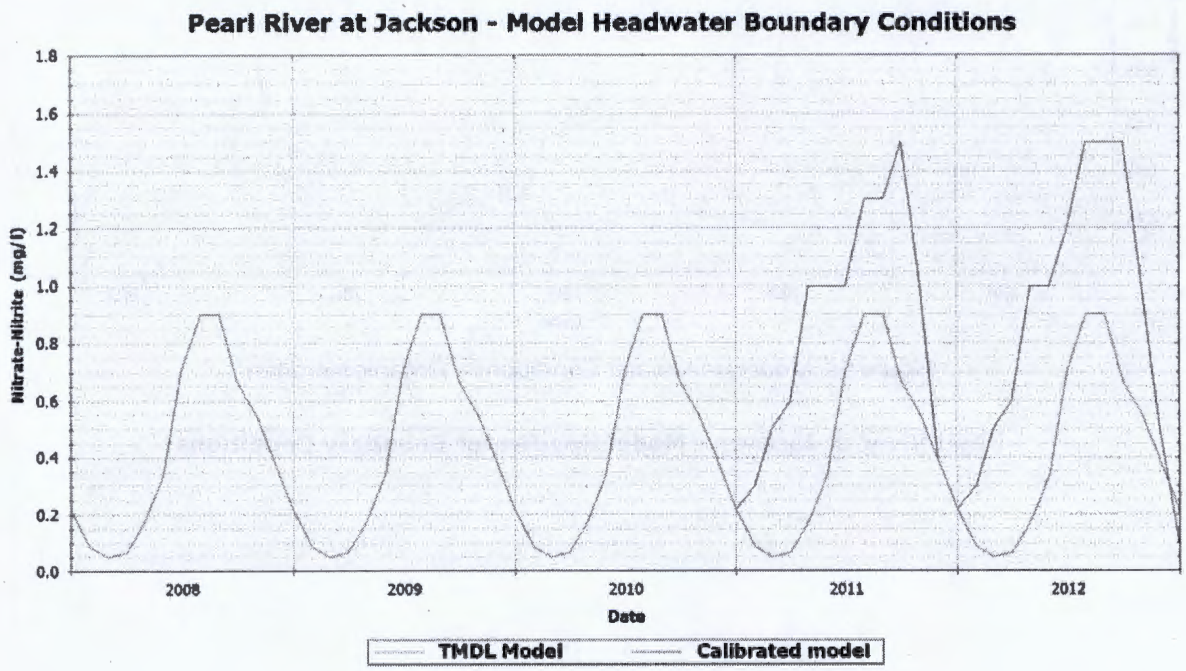

Figure 55 Model Headwater Conditions - Nitrate-Nitrite

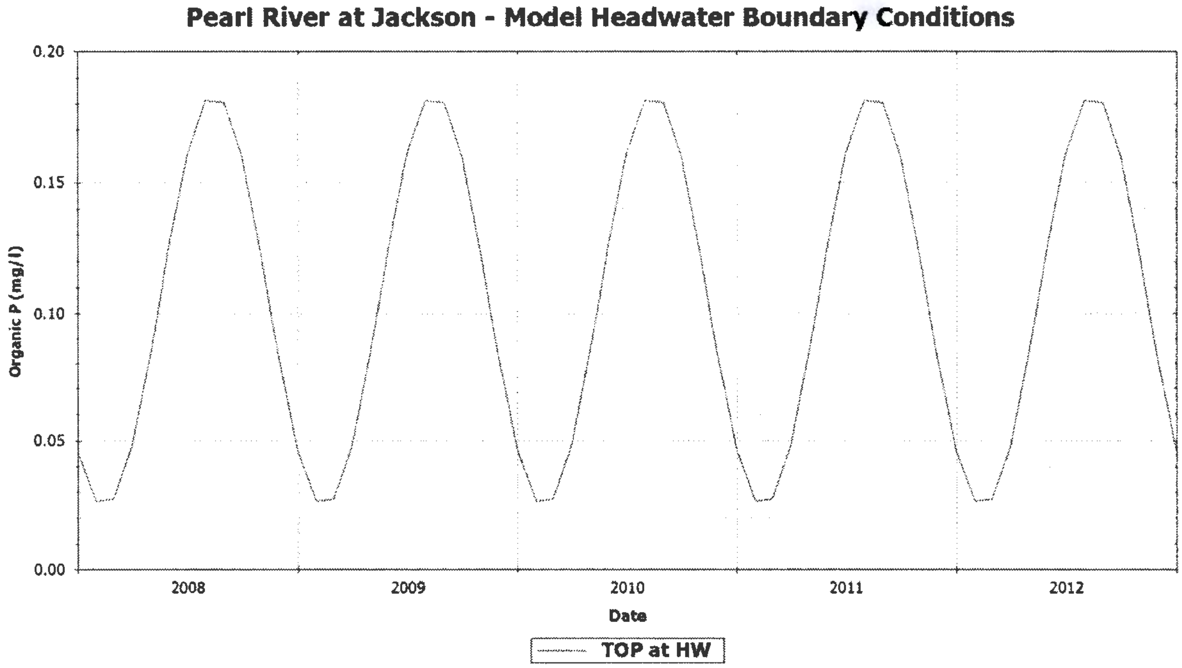

Figure 58 Model Headwater Conditions – Organic Phosphorus

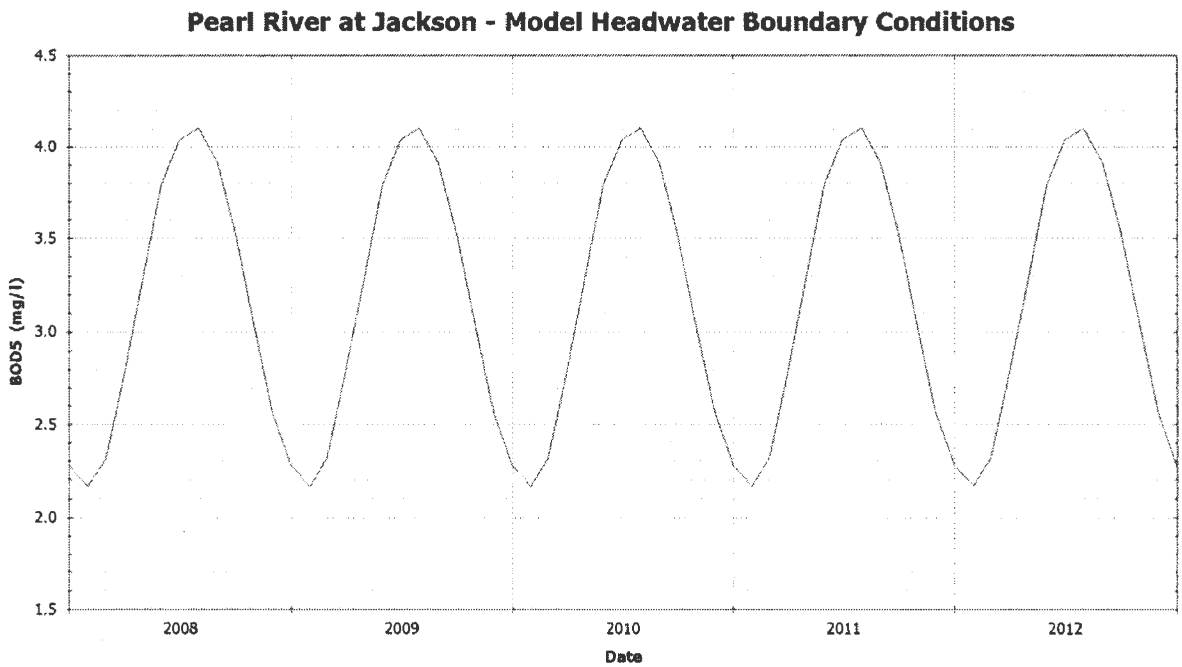

Figure 59 Model Headwater Conditions – BOD5

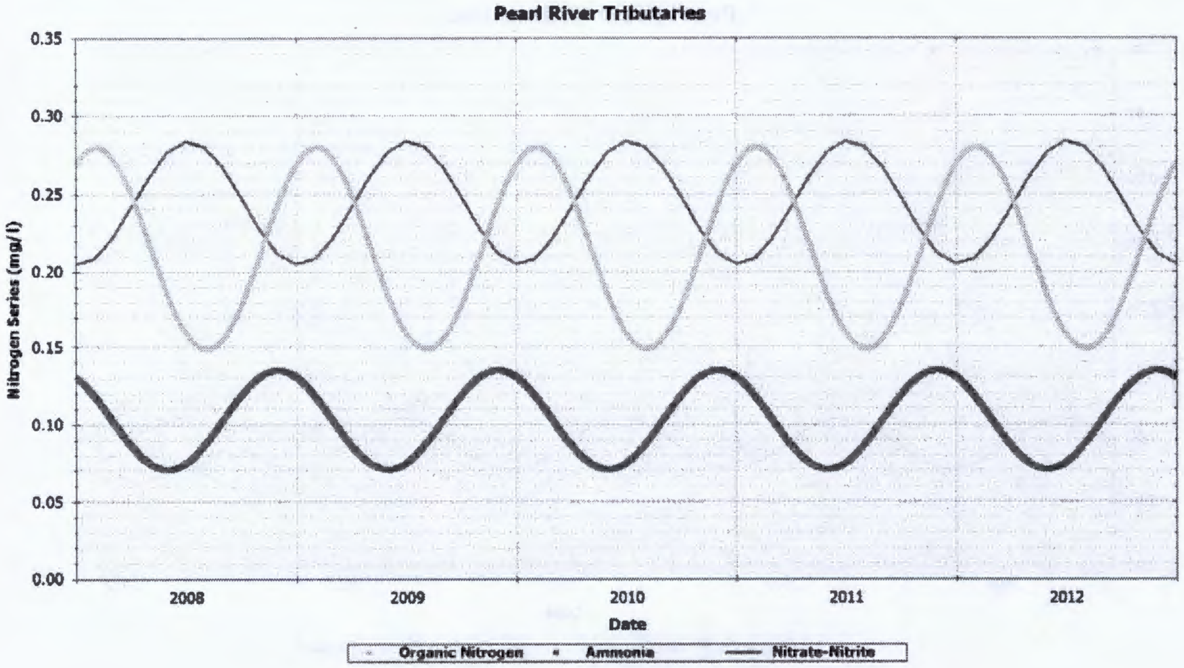

Figure 61 Pearl River Tributary – Nitrogen Series

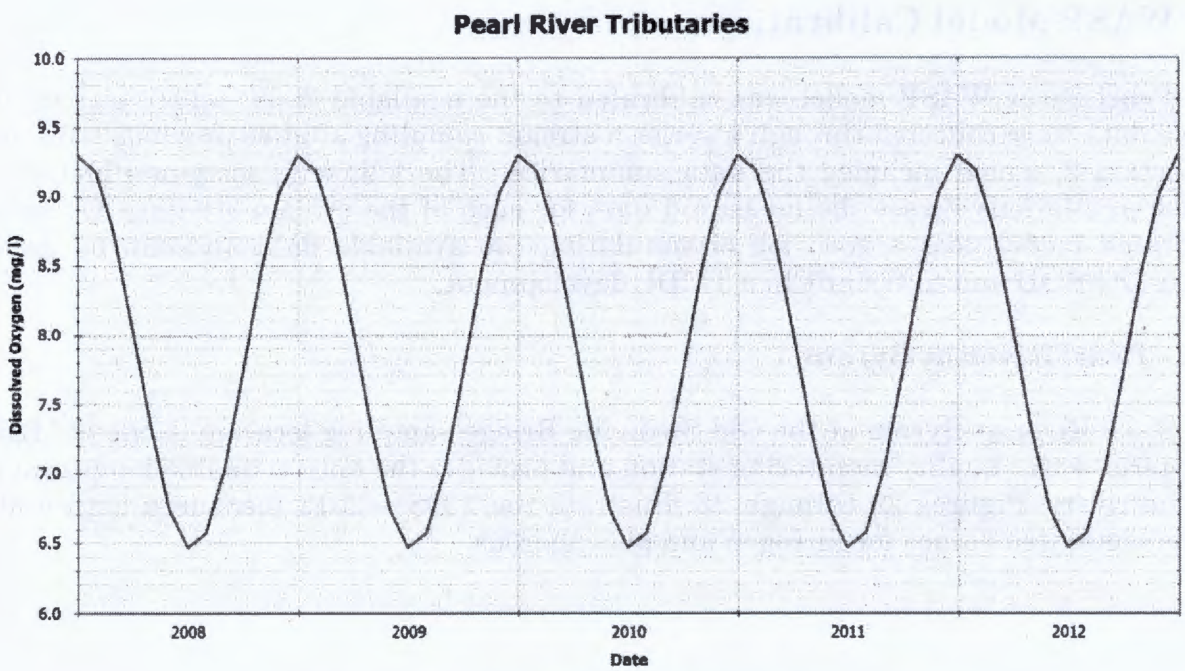

Figure 62 Pearl River Tributary – Dissolved Oxygen Series

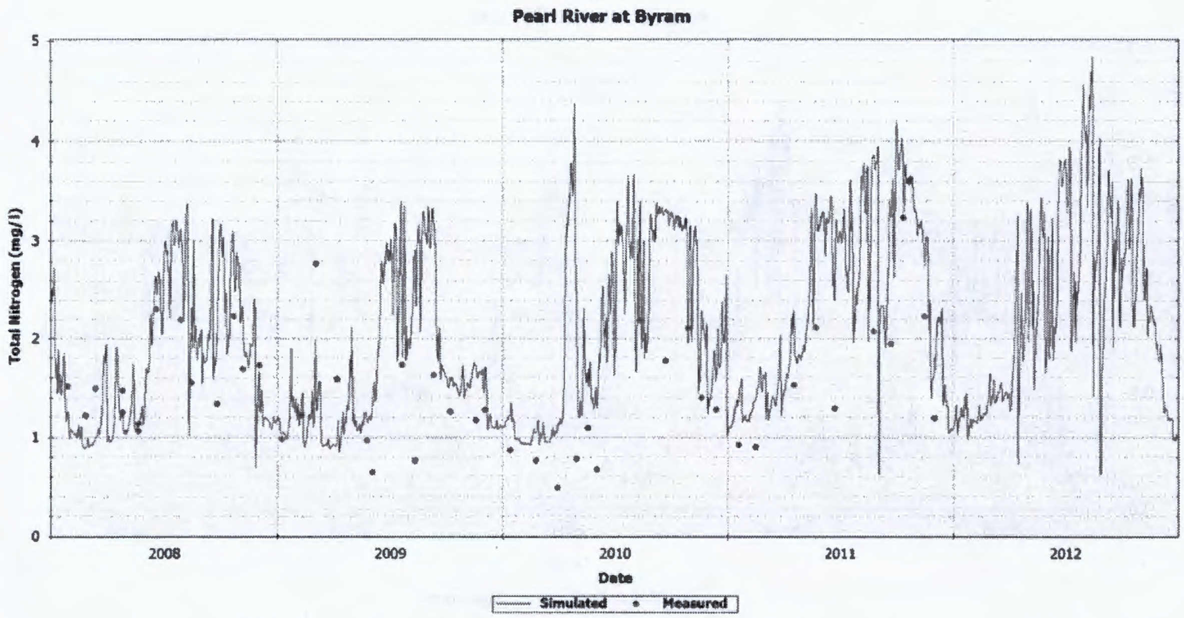

Figure 64 Pearl River at Byram – Simulated vs Measured Total Nitrogen

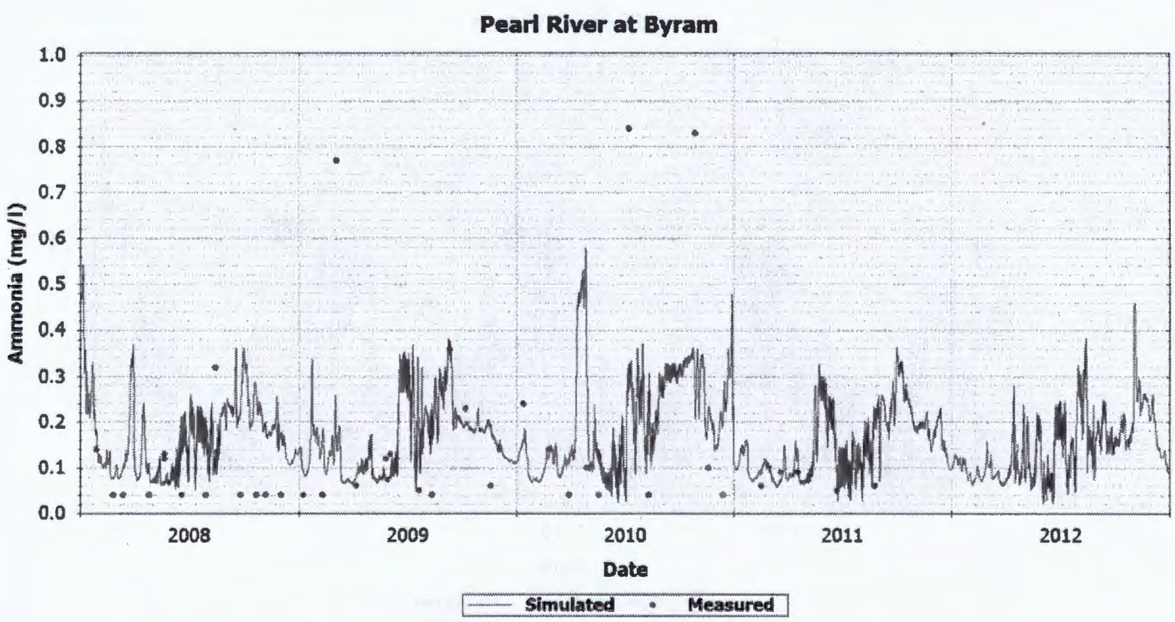

Figure 65 Pearl River at Byram – Simulated vs Measured Ammonia

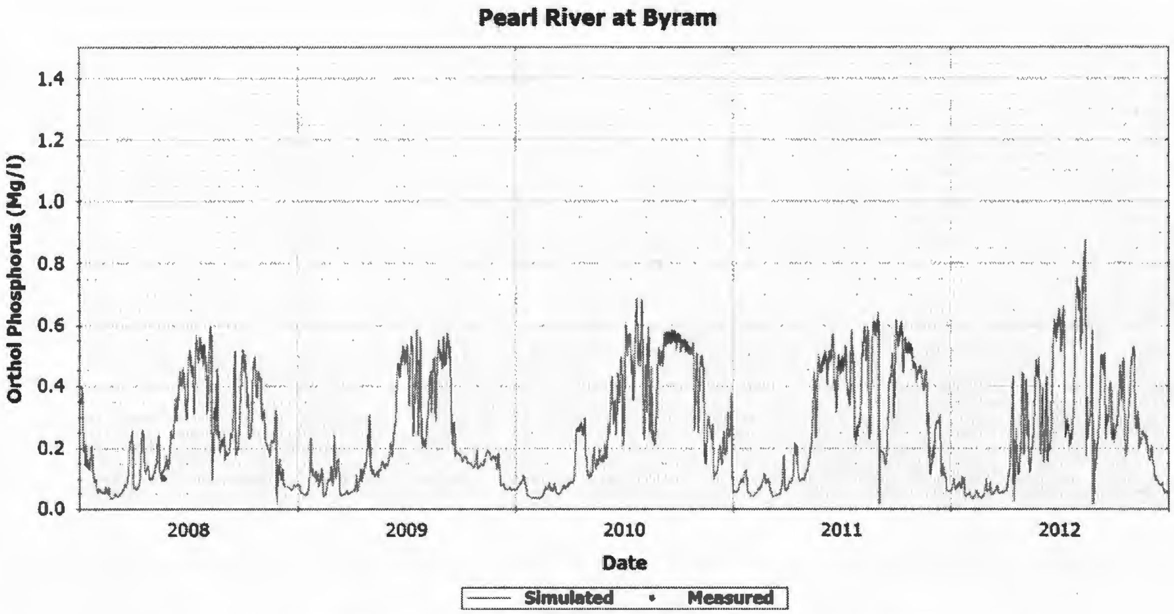

Figure 68 Pearl River at Byram – Simulated vs Measured Ortho-Phosphorous

4.3.2 Pearl River MDEQ 2008 Nutrient TMDL Study

In April and May 2008, MDEQ conducted a nutrient snapshot sampling study of the Pearl River from Jackson to Pearlington, Mississippi near the mouth of the Pearl River. Figures 34 through 54 illustrate the model predictions against measured data for TN, TP, and Chl a.

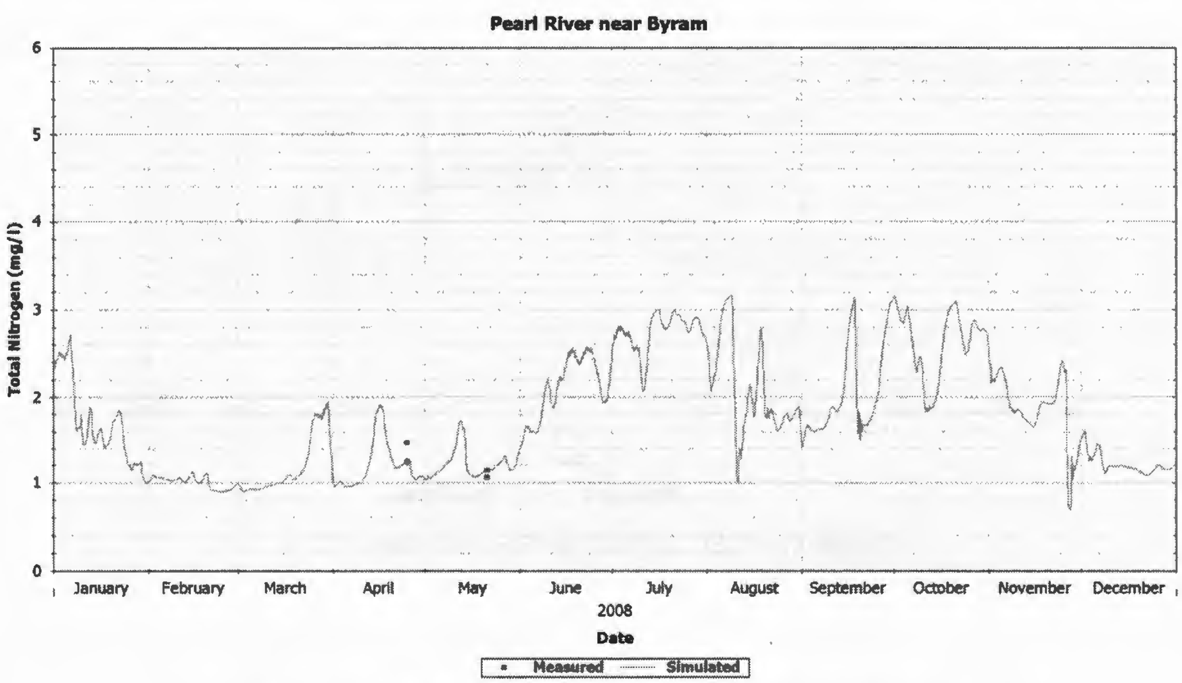

Figure 69 MDEQ Station Pearl River at Byram – Total Nitrogen

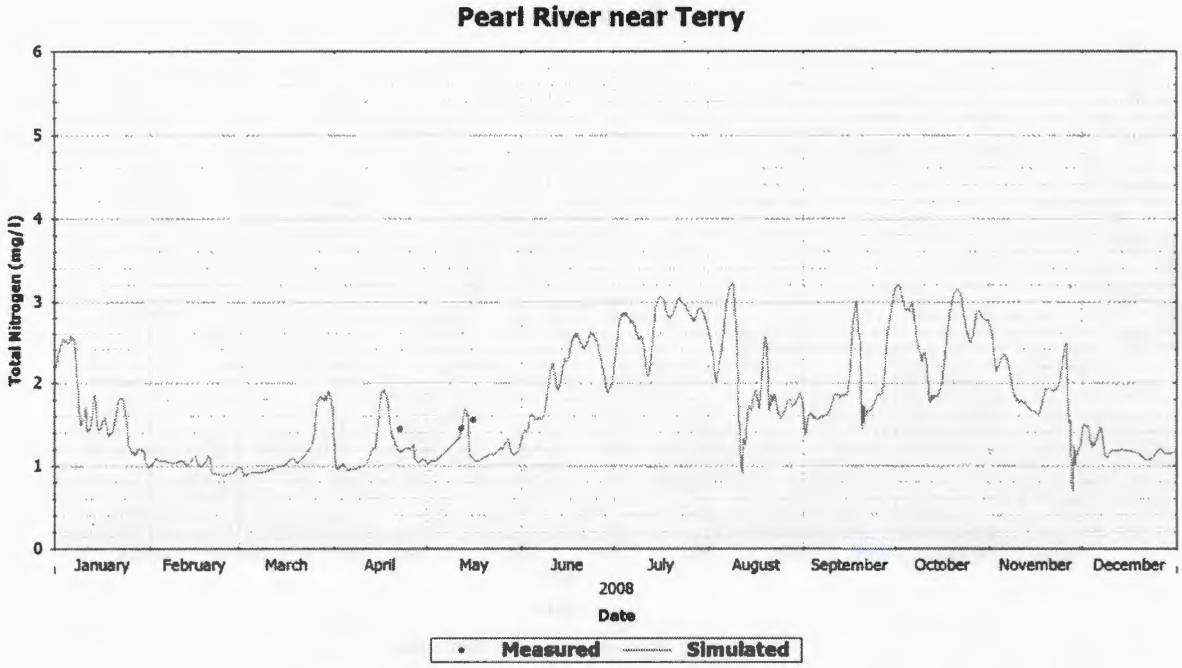

Figure 72 MDEQ Station Pearl River near Terry – Total Nitrogen

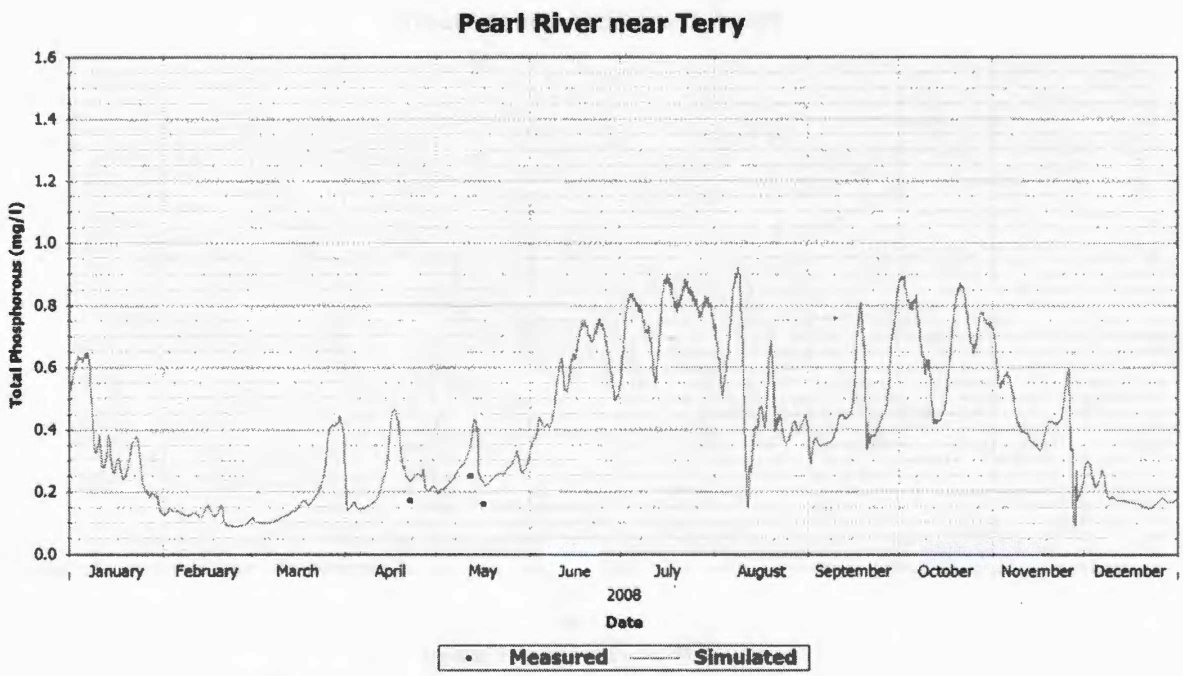

Figure 73 MDEQ Station Pearl River near Terry – Total Phosphorous

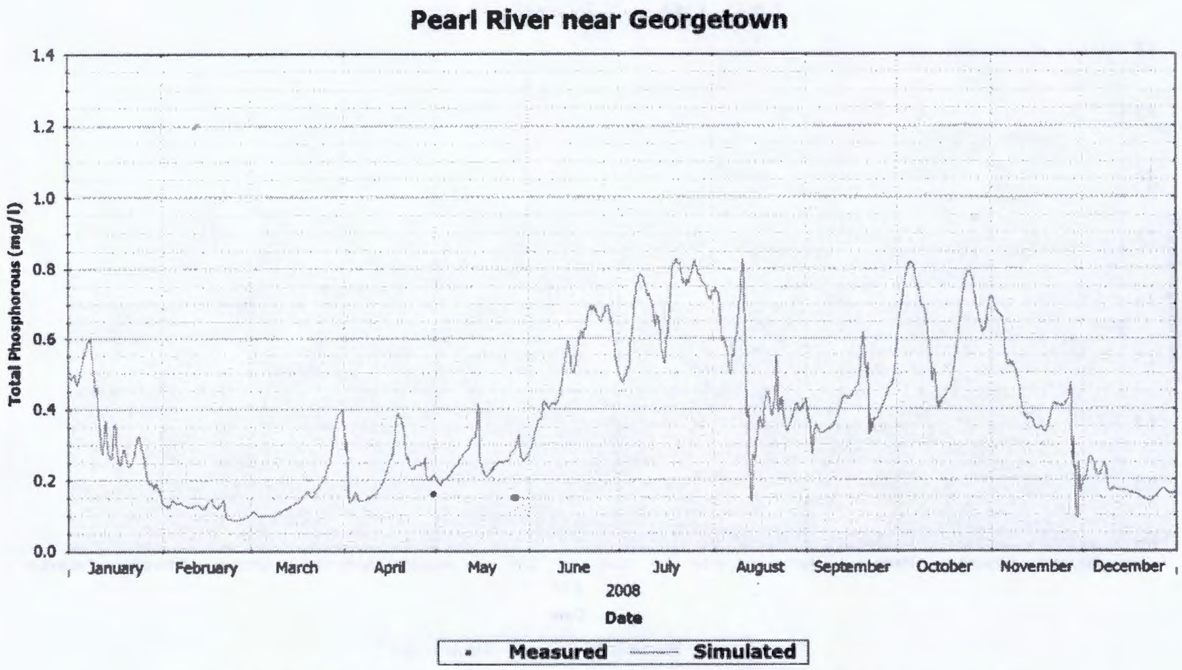

Figure 76 MDEQ Station Pearl River near Georgetown – Total Phosphorous

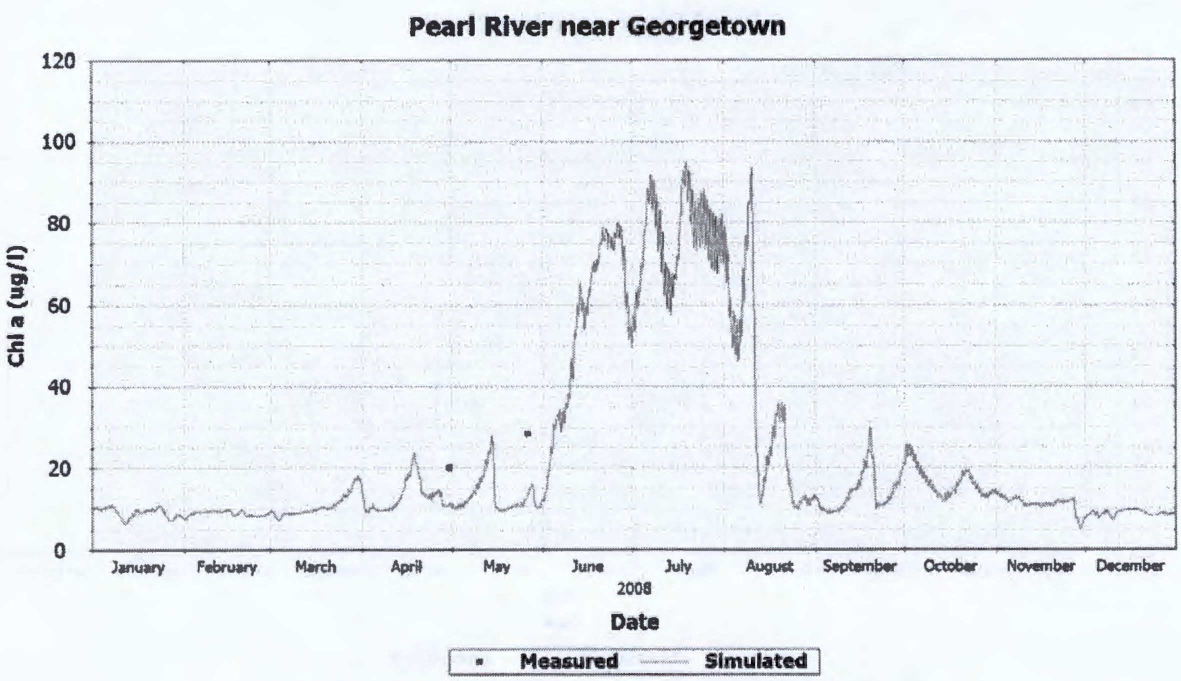

Figure 77 MDEQ Station Pearl River near Georgetown – Chl a

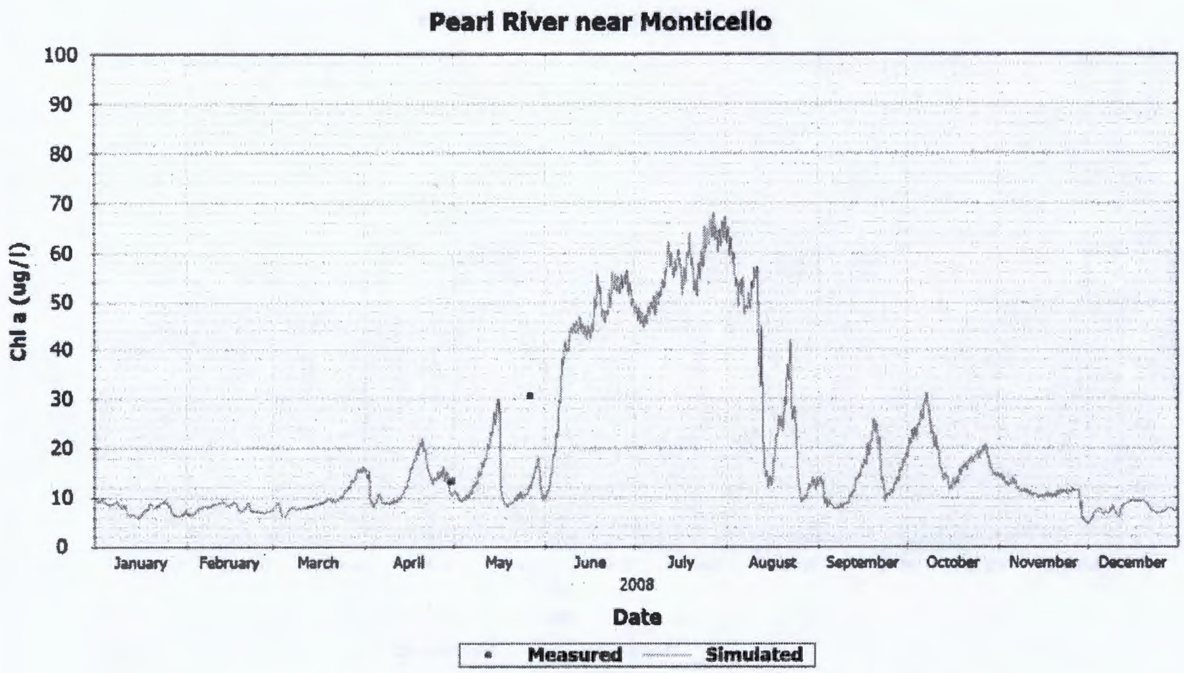

Figure 80 MDEQ Station Pearl River near Georgetown – Chl a

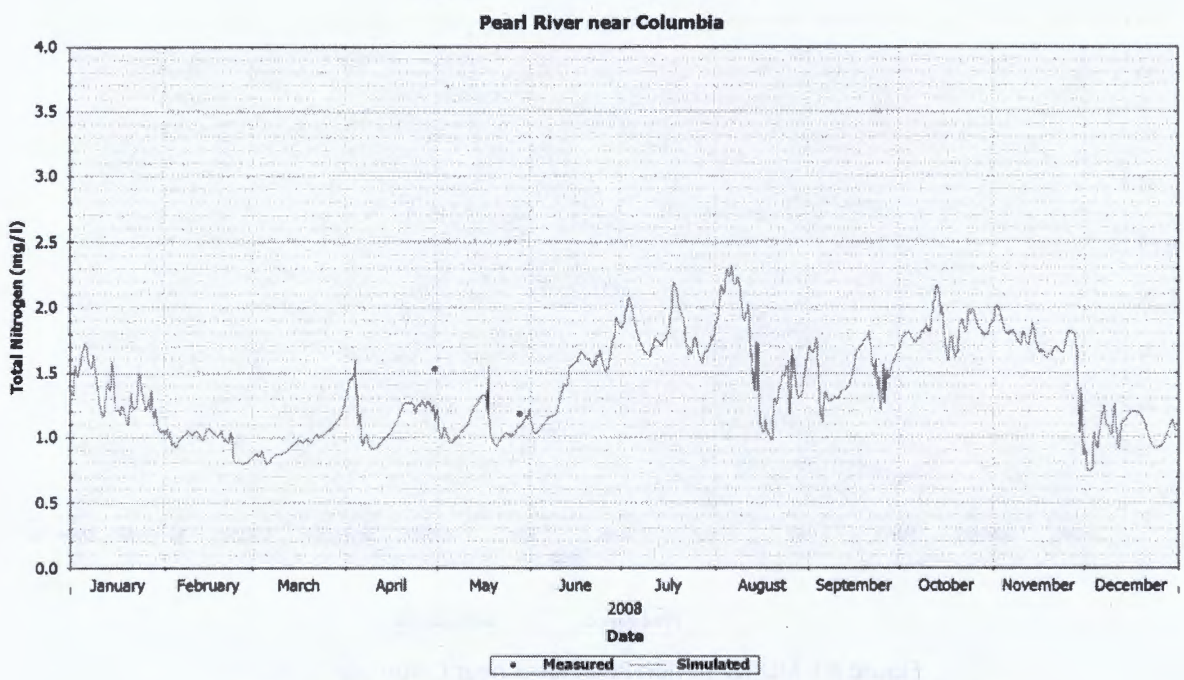

Figure 81 MDEQ Station Pearl River near Columbia – Total Nitrogen

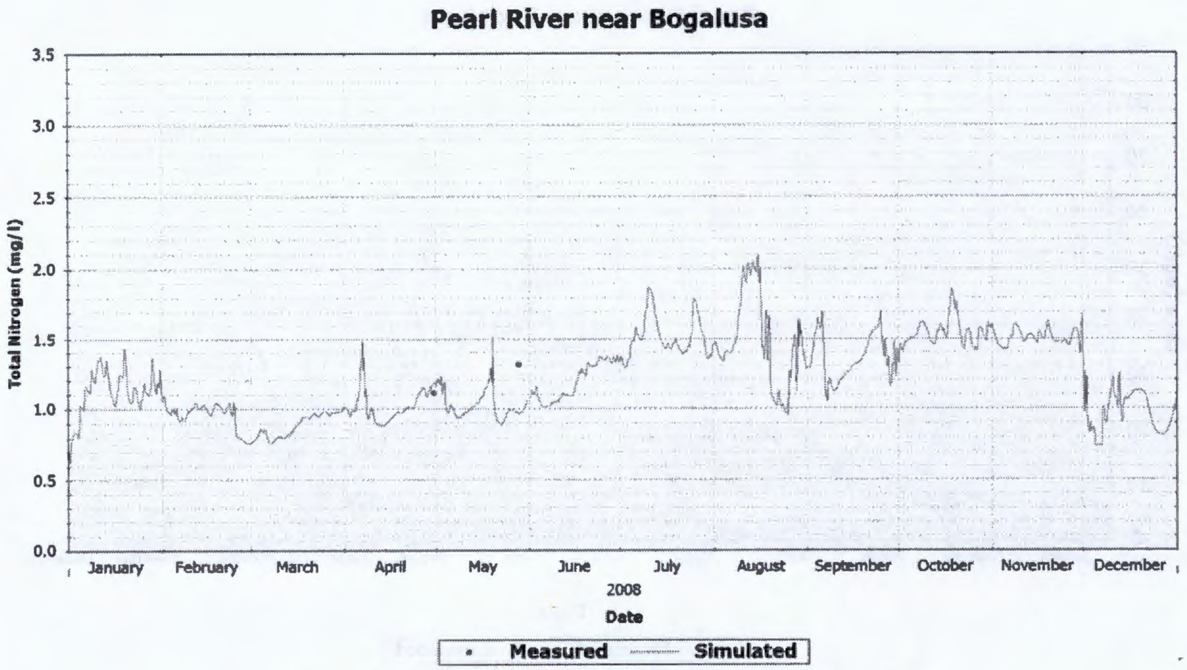

Figure 84 MDEQ Station Pearl River near Bogalusa – Total Nitrogen

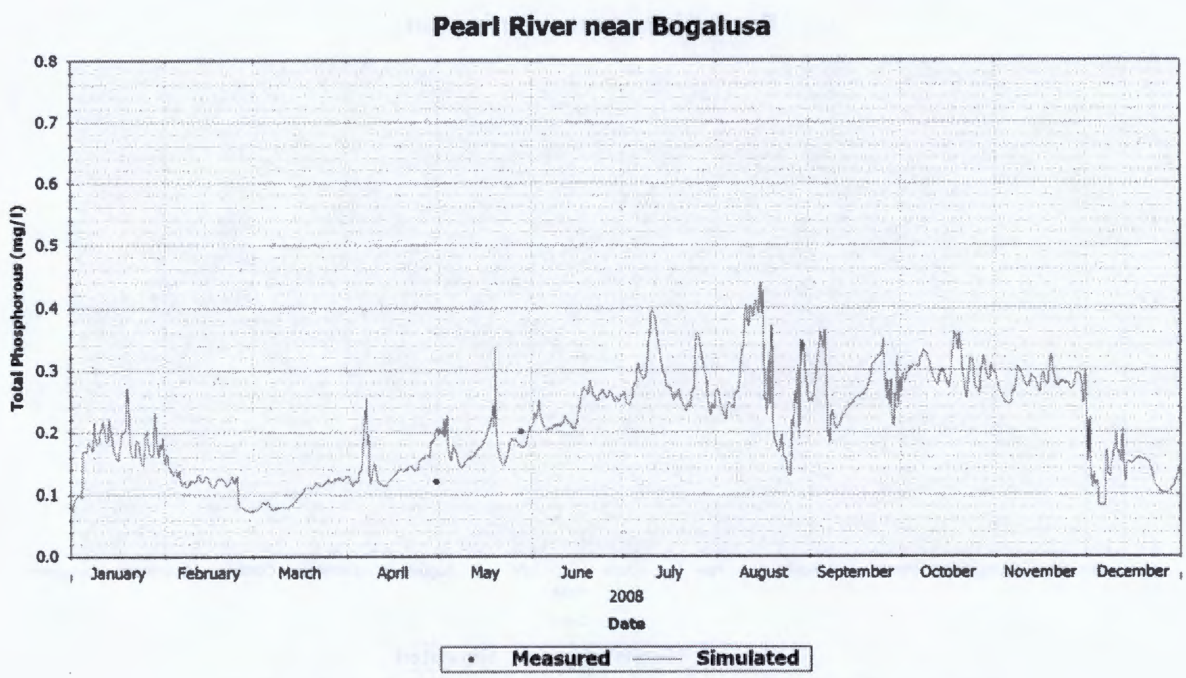

Figure 85 MDEQ Station Pearl River near Bogalusa – Total Phosphorus

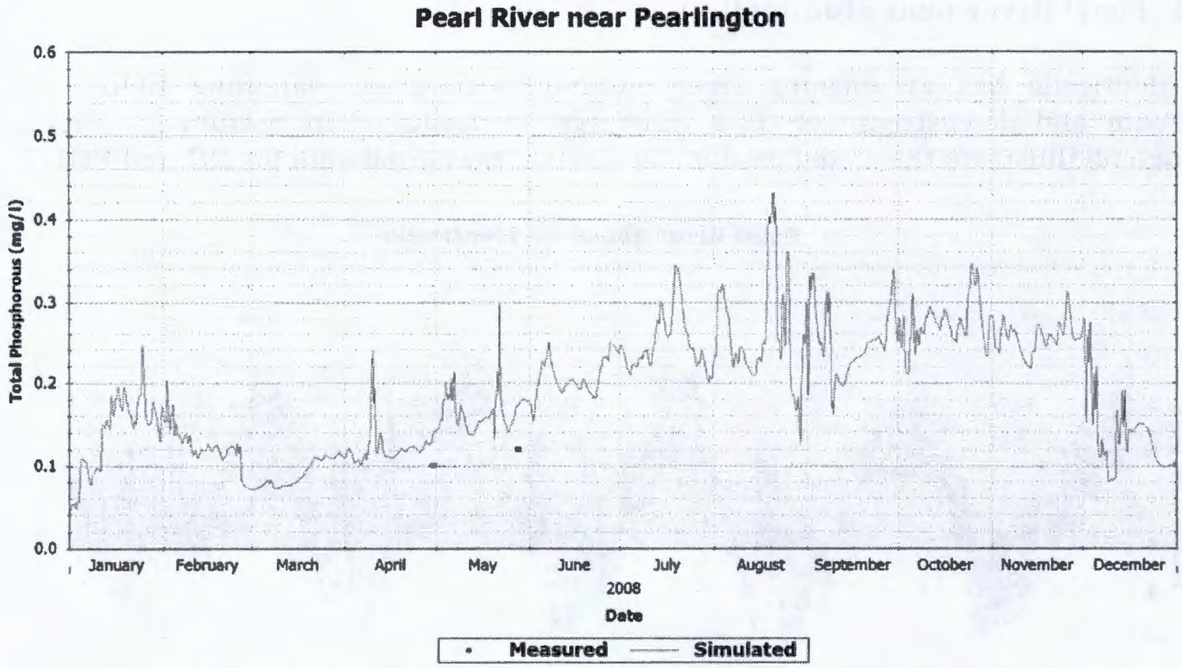

Figure 88 MDEQ Station Pearl River near Pearlington– Total Phosphorous

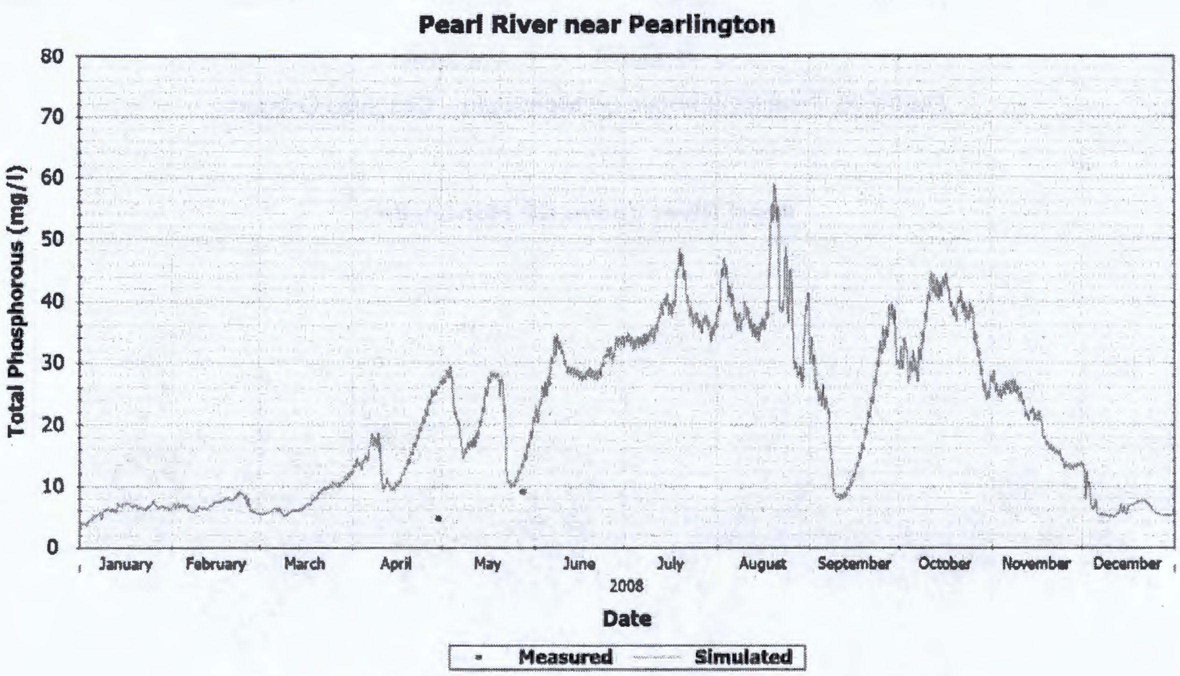

Figure 89 MDEQ Station Pearl River near Pearlington– Chl a

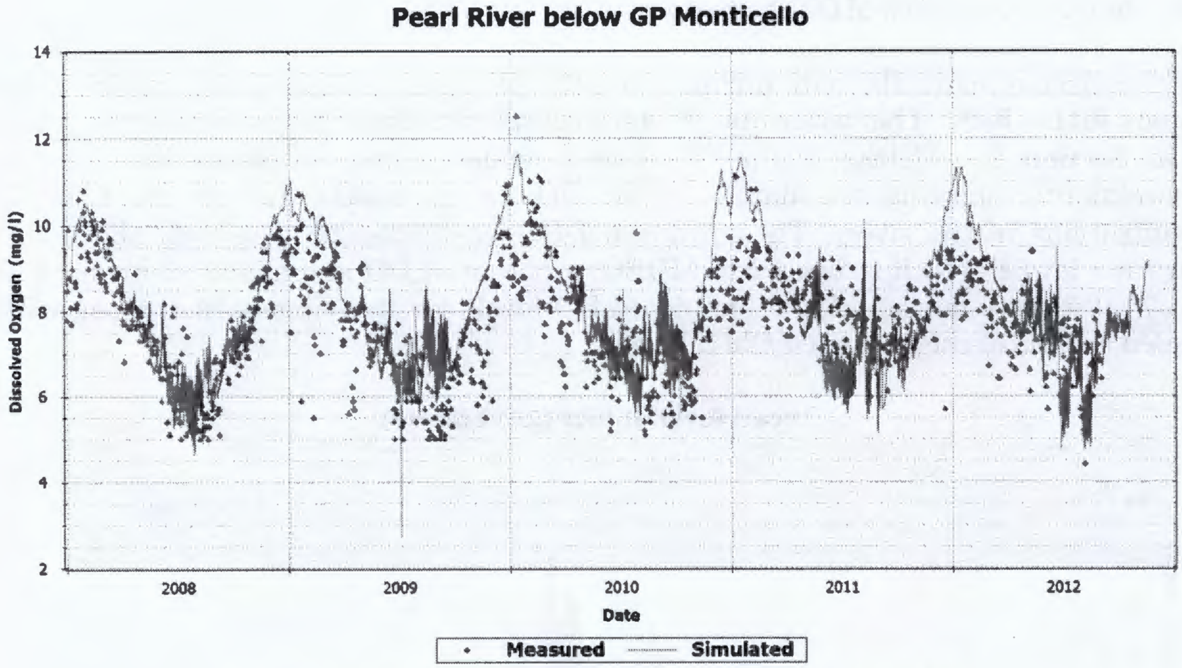

Figure 92 Pearl River below GP Monticello – Dissolved Oxygen

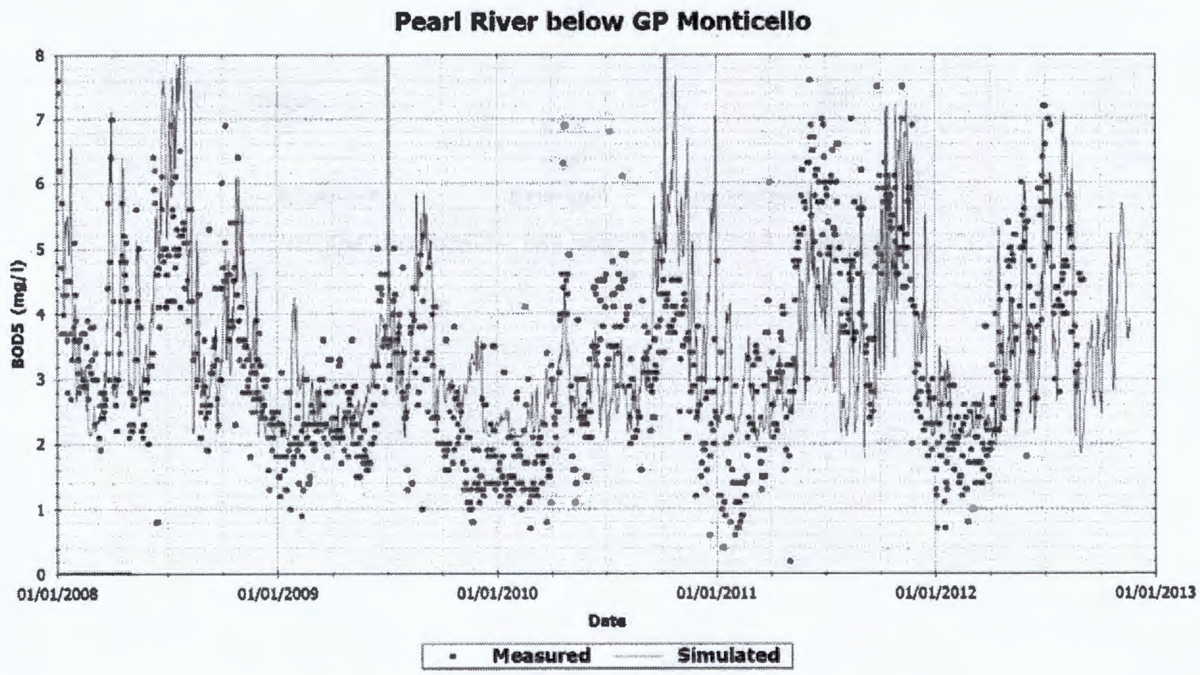

Figure 93 Pearl River below GP Monticello – BOD5

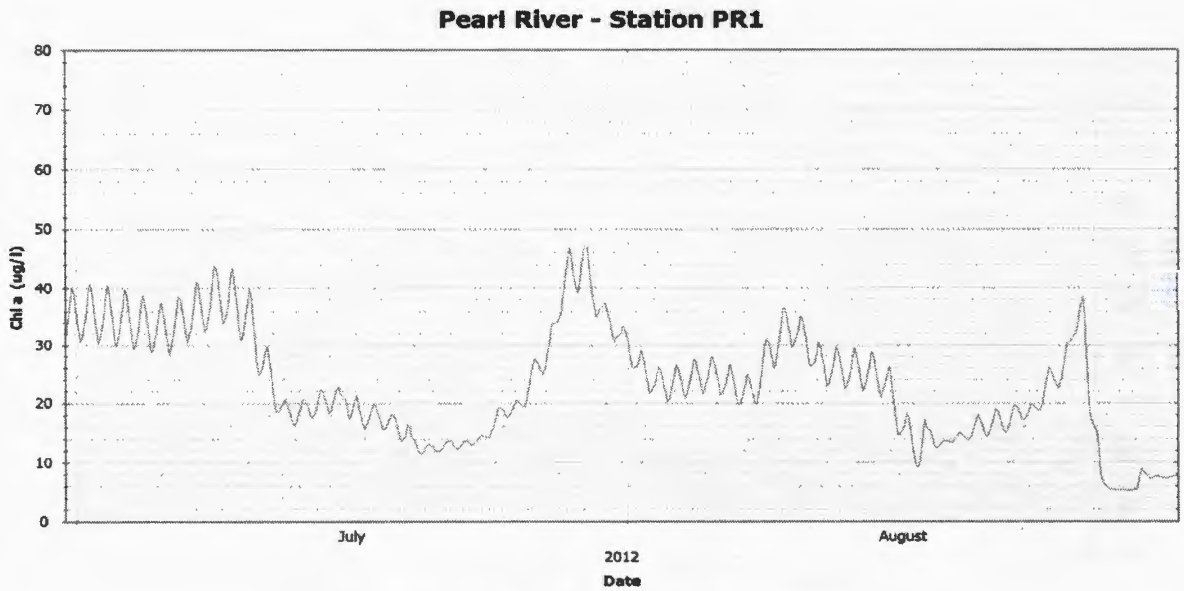

Figure 95 Pearl River Station PR1 – Chl a

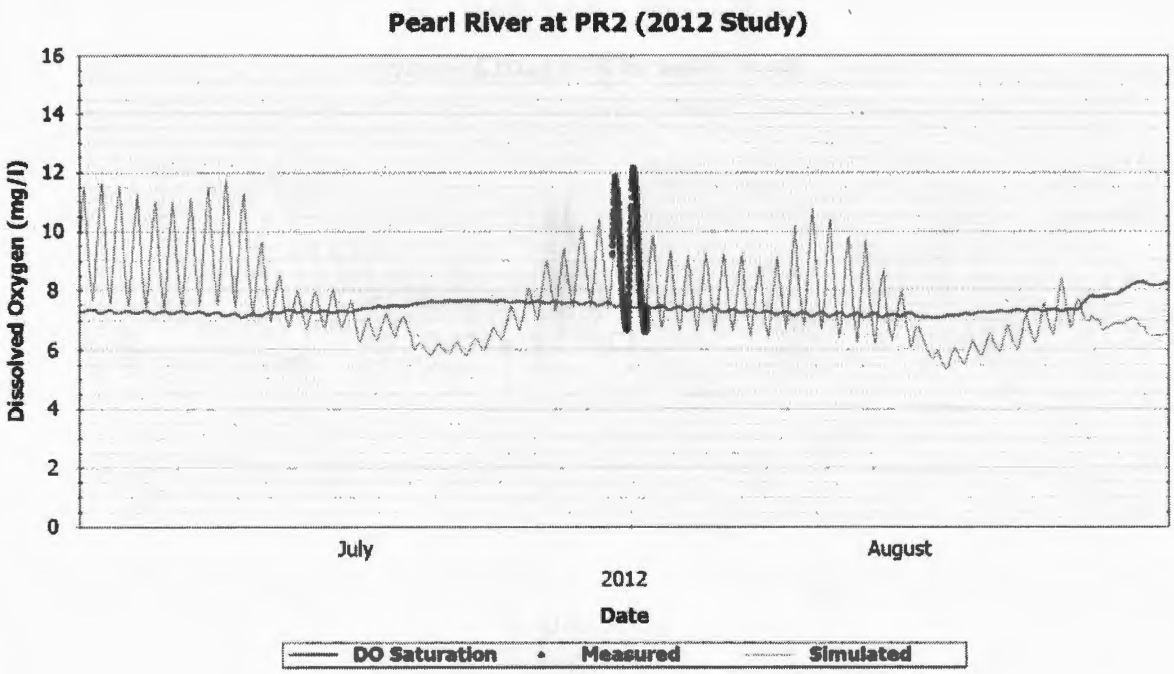

Figure 96 Pearl River Station PR2 – Dissolved Oxygen

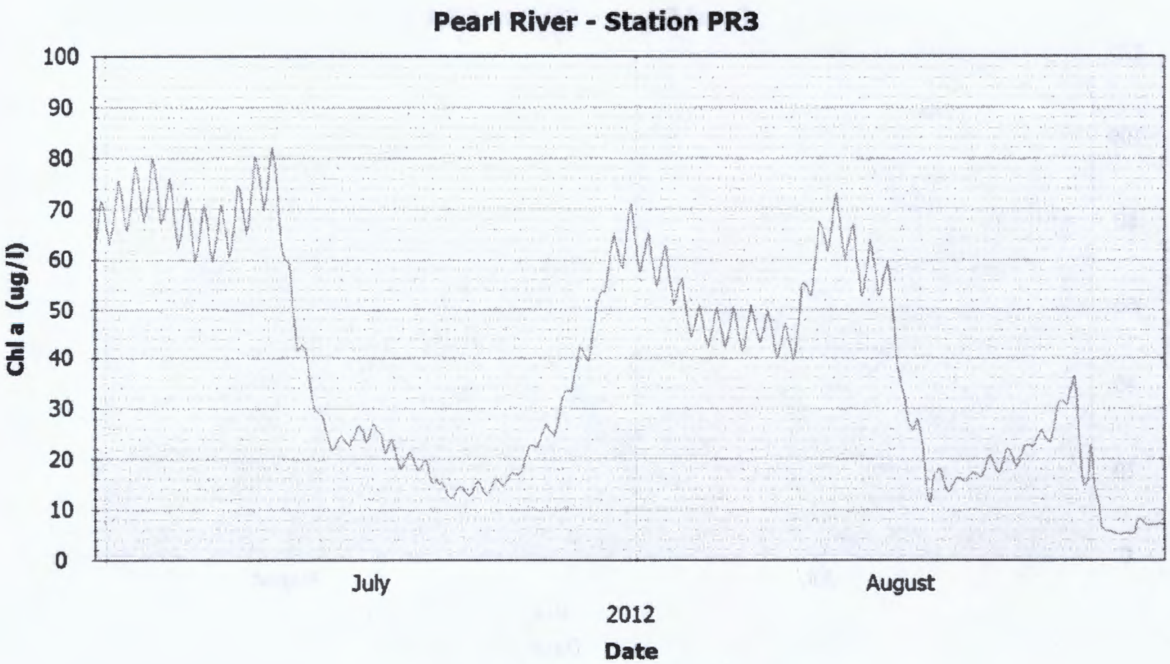

Figure 99 Pearl River Station PR3 – Chl a

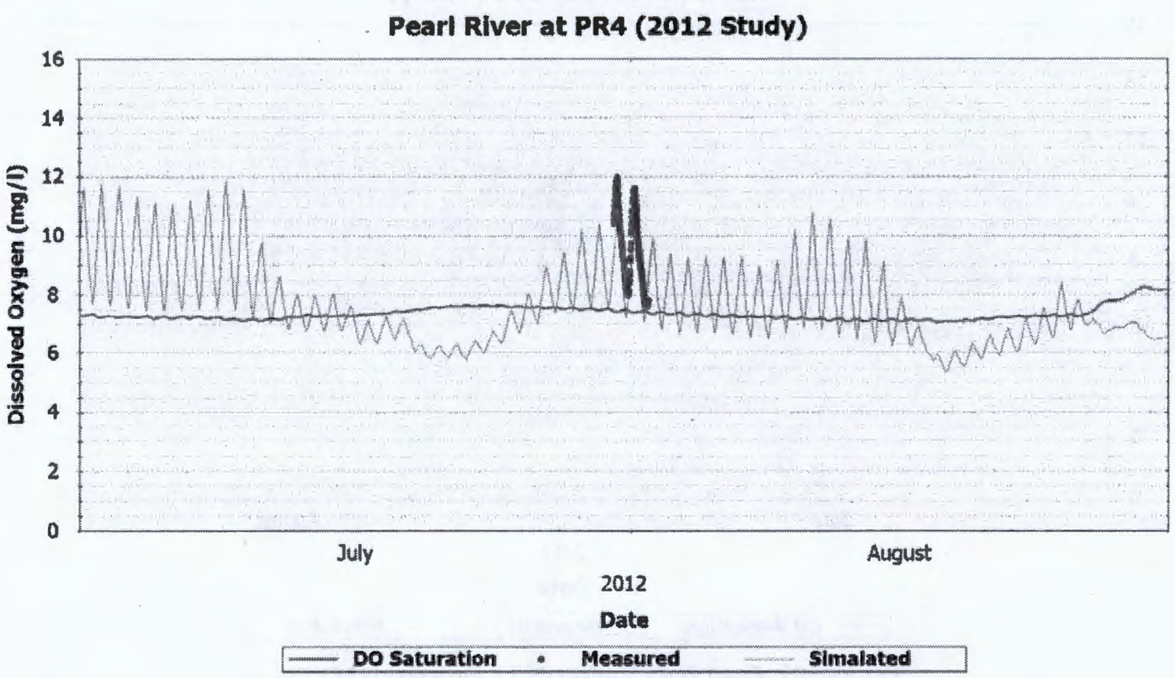

Figure 100 Pearl River Station PR4 – Dissolved Oxygen

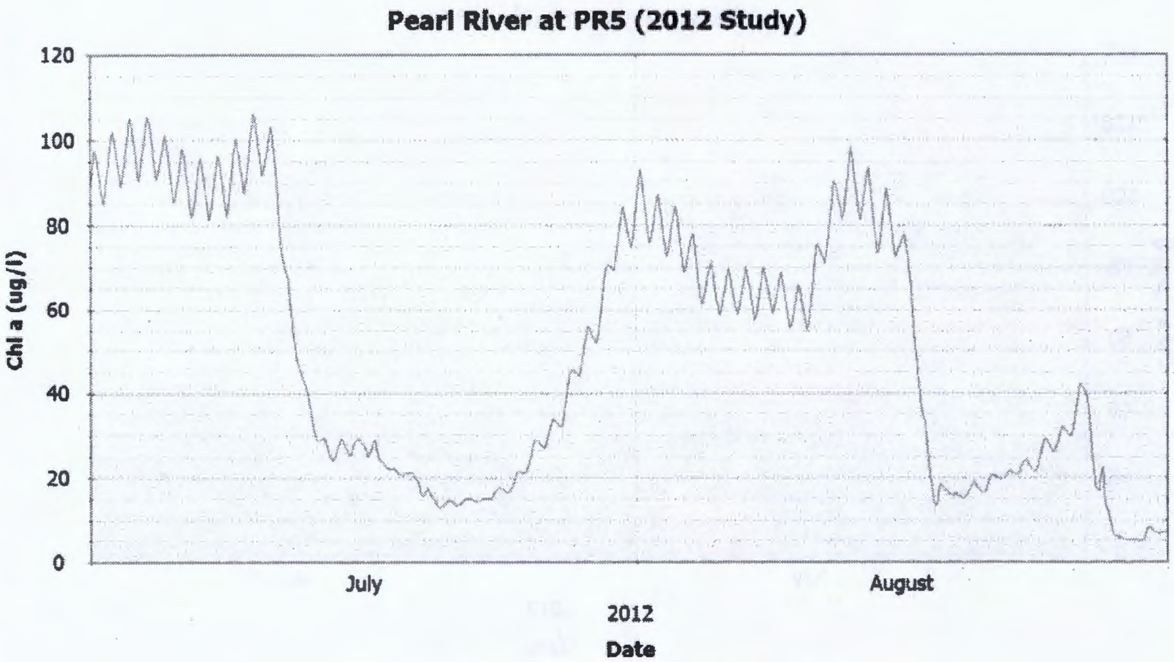

Figure 103 Pearl River Station PR5 – Chl a

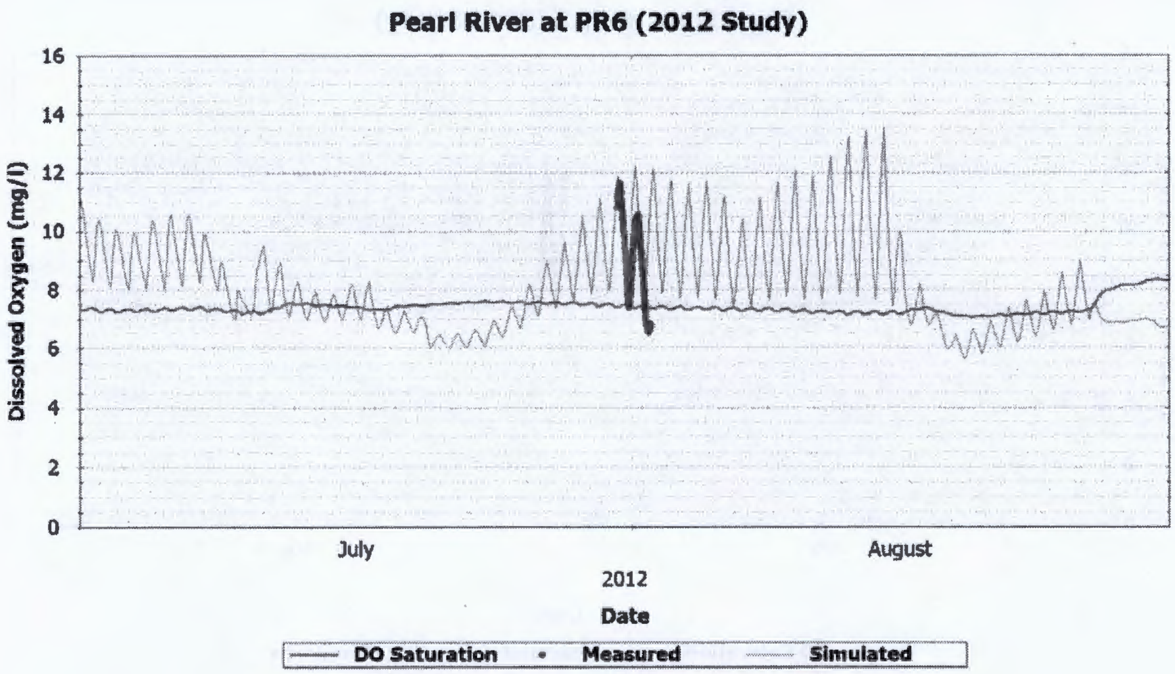

Figure 104 Pearl River Station PR6 – Dissolved Oxygen

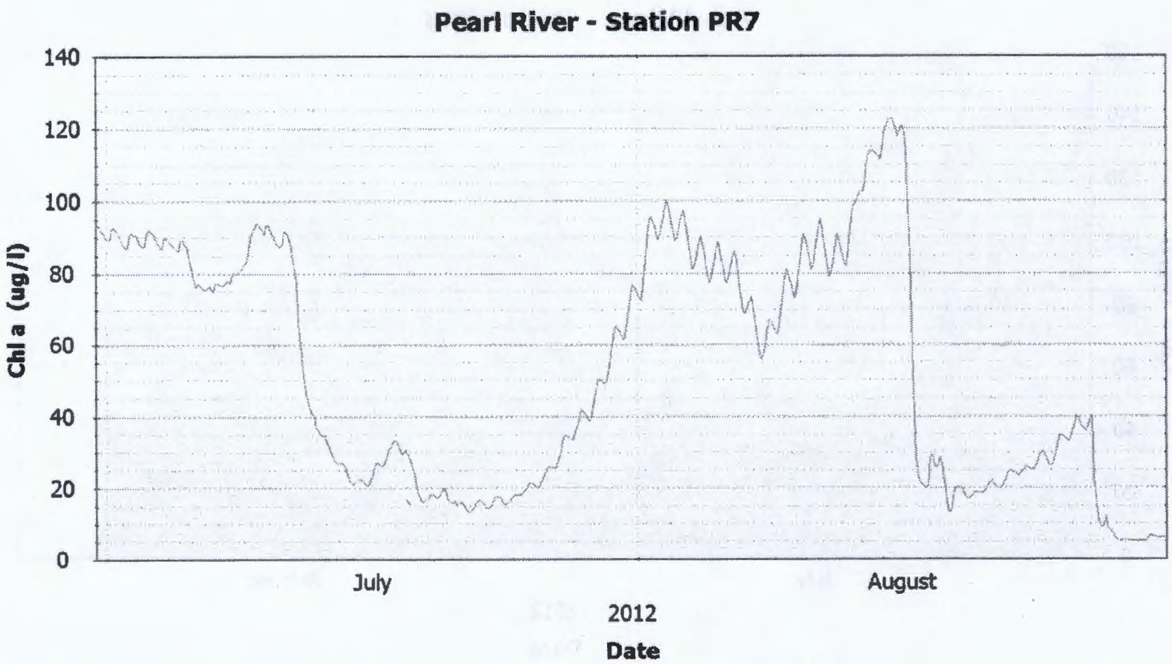

Figure 107 Pearl River Station PR7 – Chl a

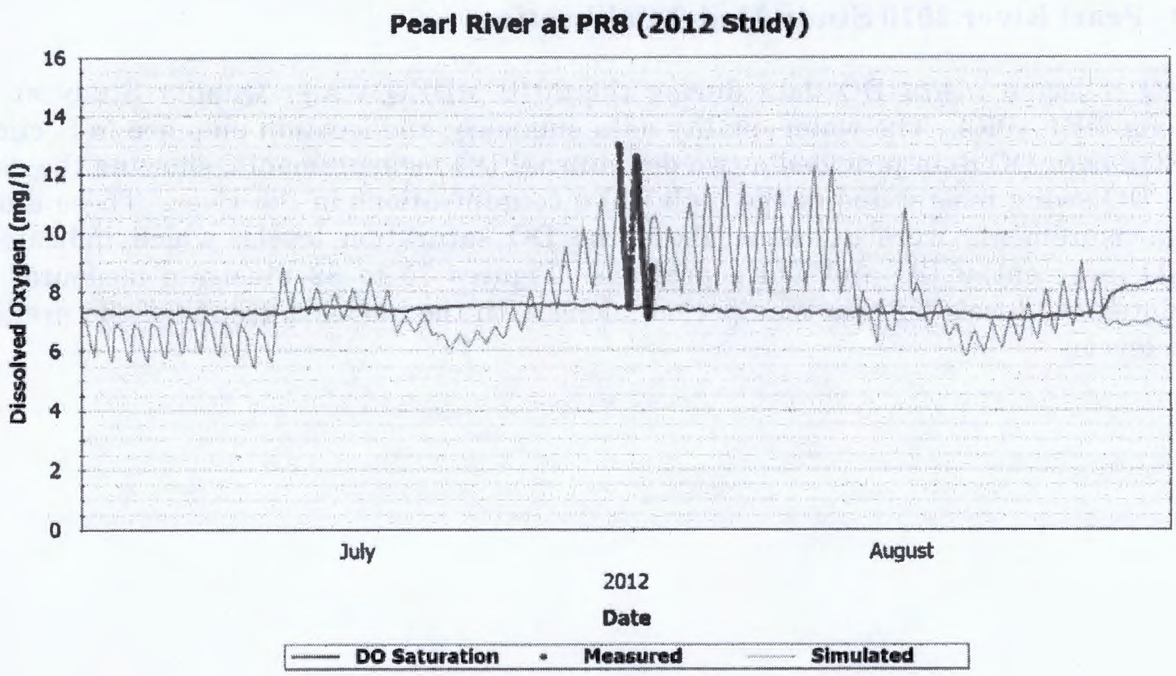

Figure 108 Pearl River Station PR8 – Dissolved Oxygen

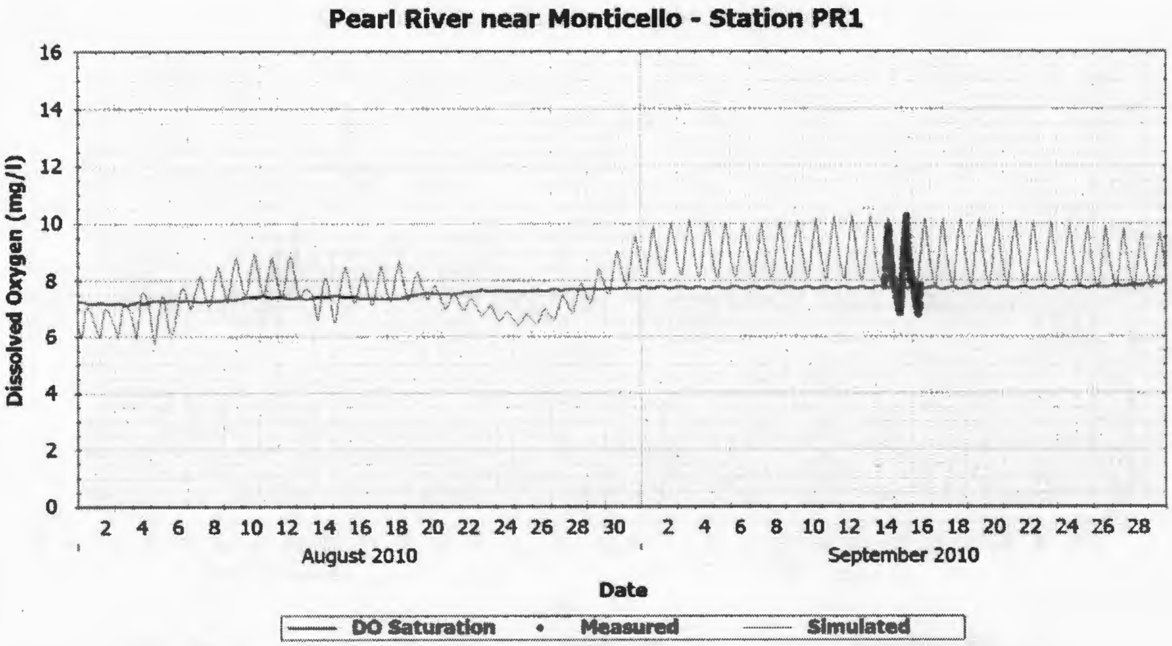

Figure 110 Pearl River near Monticello Station PR1 – Dissolved Oxygen

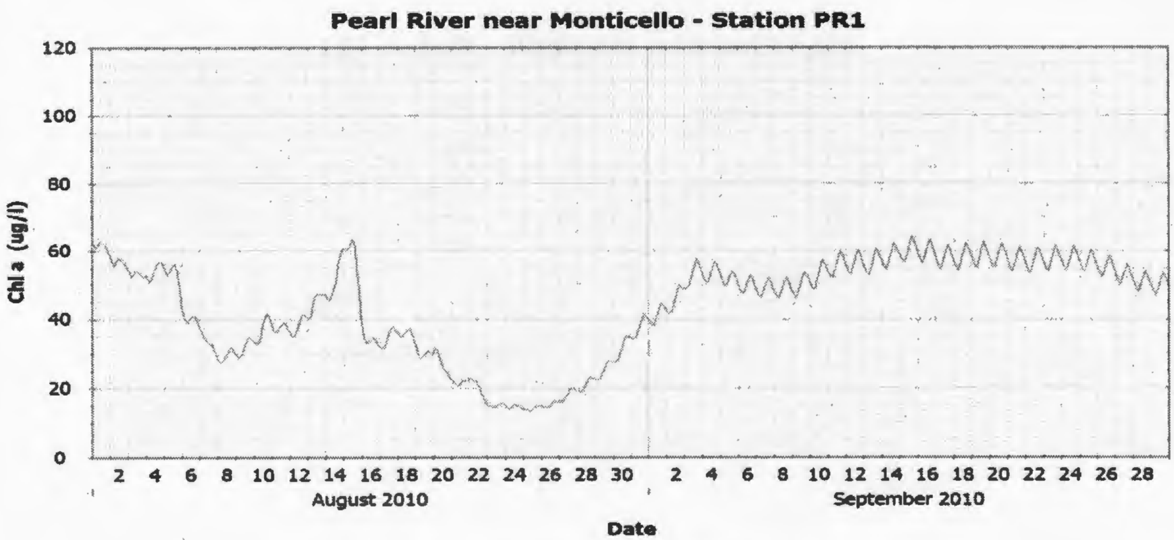

Figure 111 Pearl River near Monticello Station PR1 – Chl a

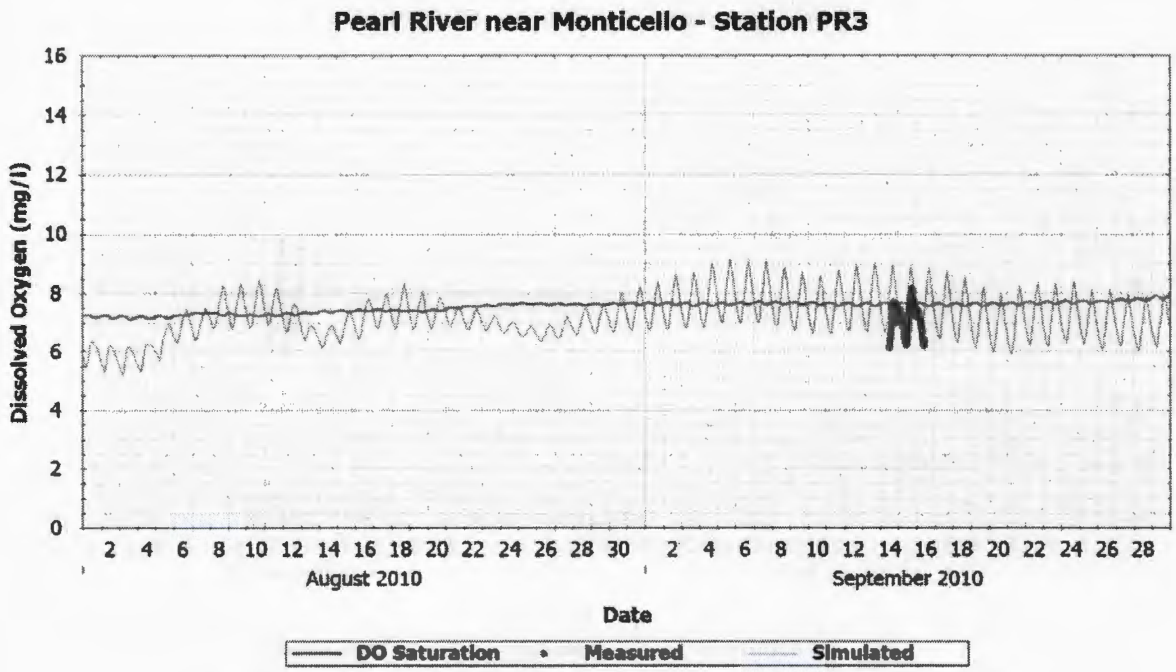

Figure 114 Pearl River near Monticello Station PR3 – Dissolved Oxygen

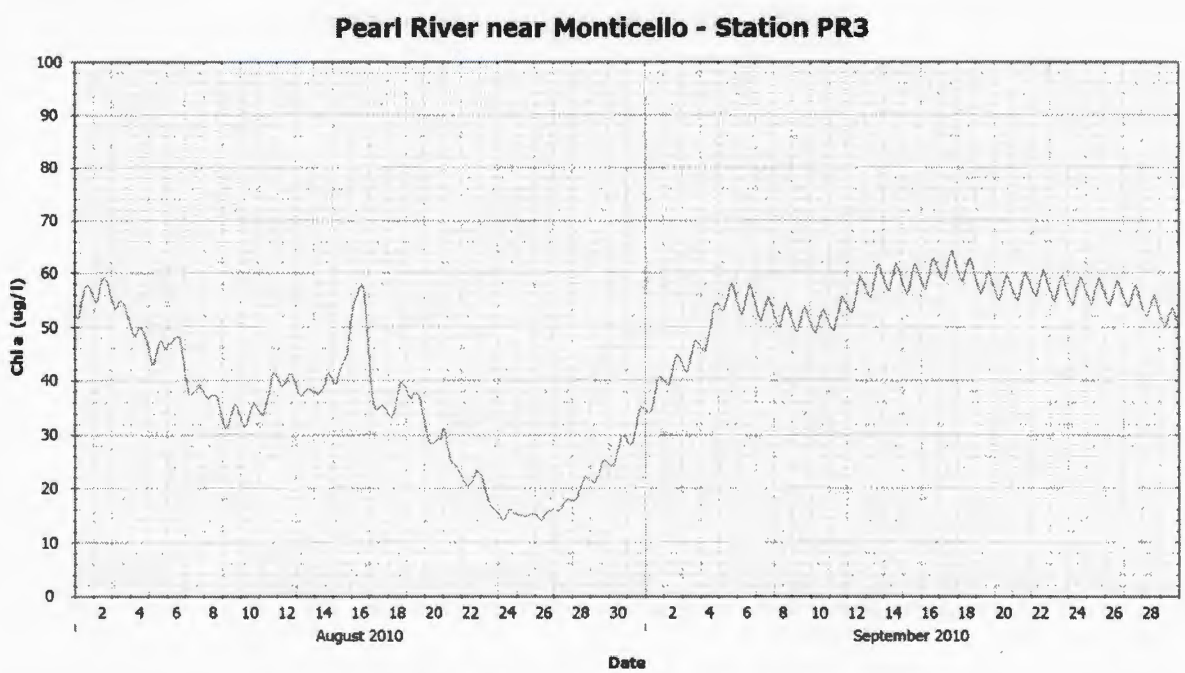

Figure 115 Pearl River near Monticello Station PR3 – Chl a

5.0 Pearl River TMDL Model

The 2008 – 2012 Pearl River model is calibrated as good as possible with the available data. Overall the model does a good job in replicating the nutrient concentrations, BOD5, Chl a, and DO levels measured in the Pearl River.

In discussions with MDEQ, the time frame, 2008 – 2012, is a good time frame for TMDL development, in that these years encompass a variety of flow ranges, especially low flow during the critical 2008 summer months. Therefore with the minor correction to the headwater nitrate-nitrite time series discussed previously in Section 4, the model is adequate for nutrient and DO TMDL development.

Although this model covers the Pearl River from Jackson down past Bogalusa, the specific concern of this report is modeling GP Monticello's impact on water quality. The main area of focus is Pearl River near Monticello and parameter of concern is low DO levels due to the discharge of BOD5 and ammonia from GP Monticello's effluent. Also of concern is what impact GP Monticello nutrient discharge has on diurnal DO levels that exceed the DO saturation due to high Chl a levels.

5.1 Pearl River Dissolved Oxygen Low Flow Model

Summer 2008 represents a low flow high temperature period when DO levels are expected to be at the lowest values. MDEQ noted that during their 2010 study the DO levels in the Pearl River continued to drop as they sampled further downstream of GP Monticello's discharge. The DO TMDL model confirms this observation and the area of the DO sag or lowest predicted DO values is about 30 kilometers downstream of the discharge. For all 6 years the minimum daily average DO was above the MDEQ DO water quality standard of 5.0 mg/l. Figures 83 to 87 illustrate the daily average DO concentrations at five sites on the Pearl River – upstream and 10, 20 25, and 30 kilometers (km) downstream of GP Monticello's discharge. The DO sag area or area of lowest DO is at 25 km below GP Monticello as illustrated in Figure 86.

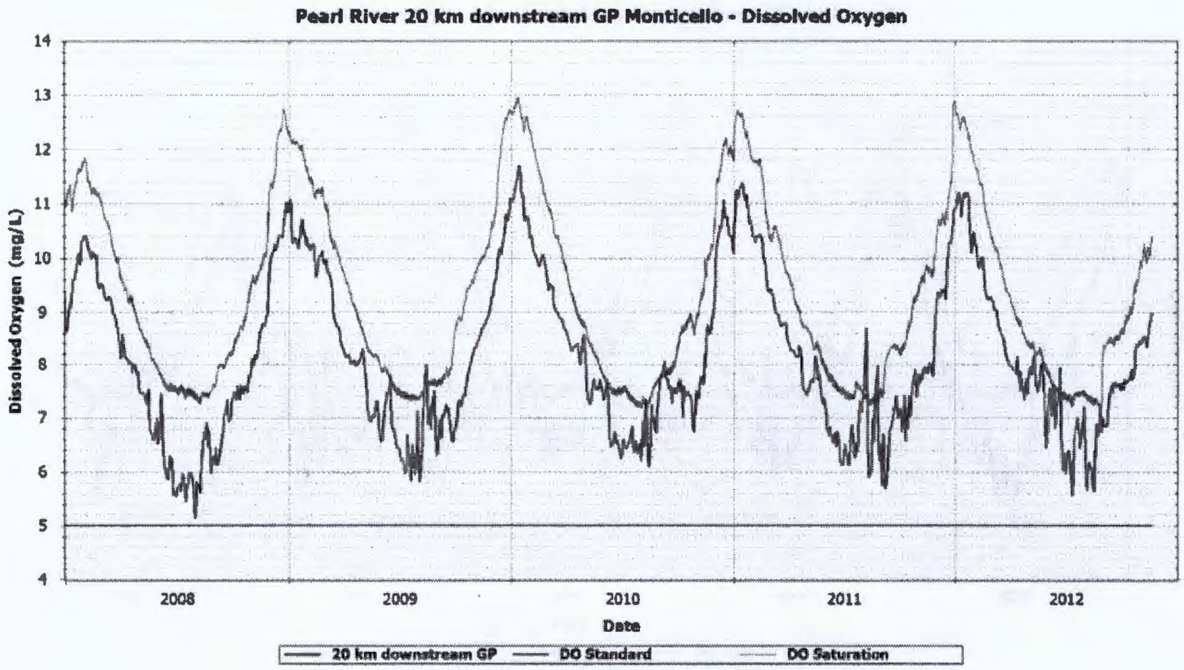

Figure 120 Pearl River 20 km downstream GP – Dissolved Oxygen

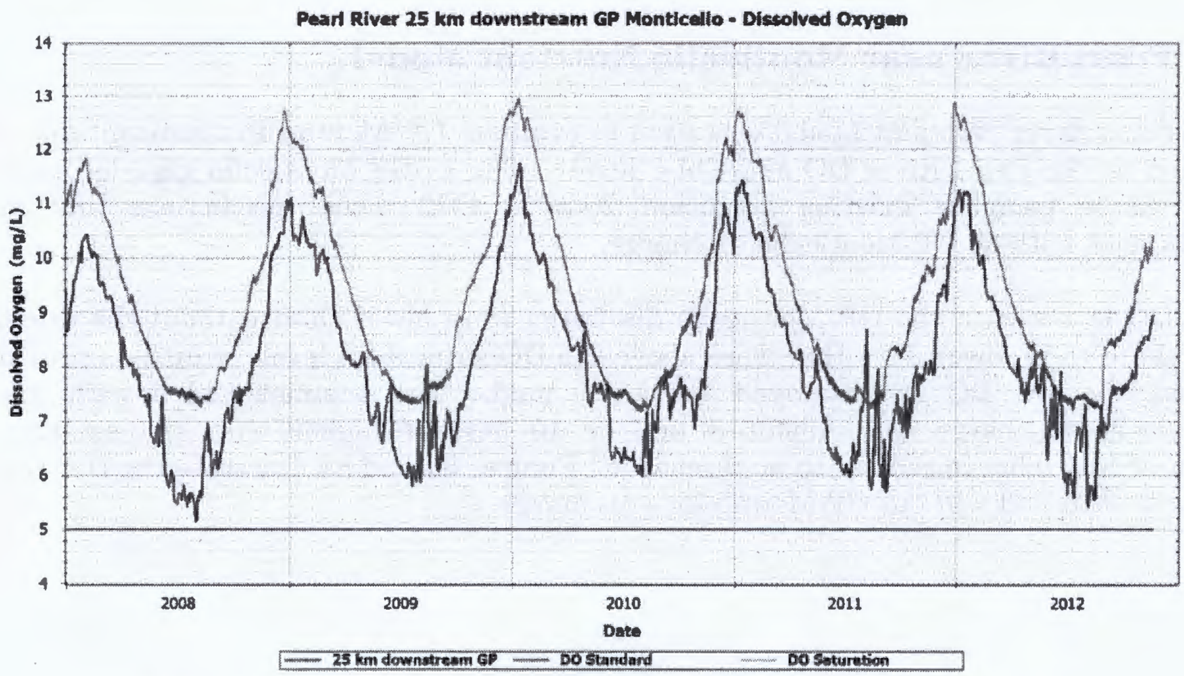

Figure 121 Pearl River 25 km downstream GP – Dissolved Oxygen – DO Sag Area

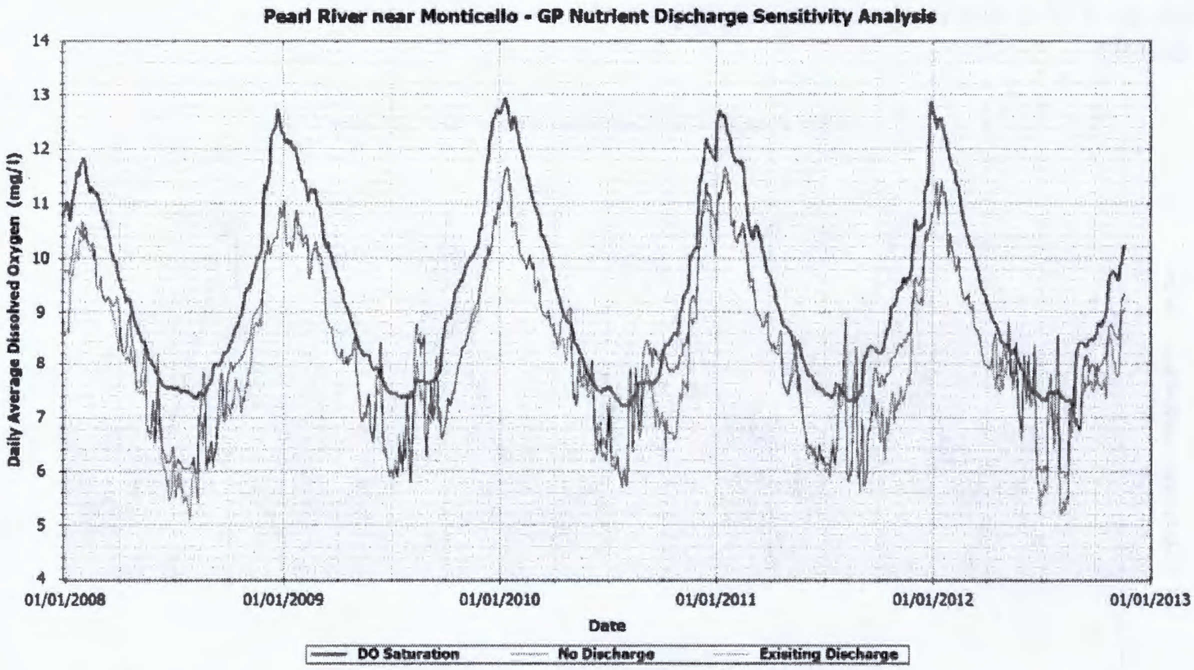

Figure 123 Pearl River Nutrient Sensitivity Analysis – Daily Average Dissolved Oxygen

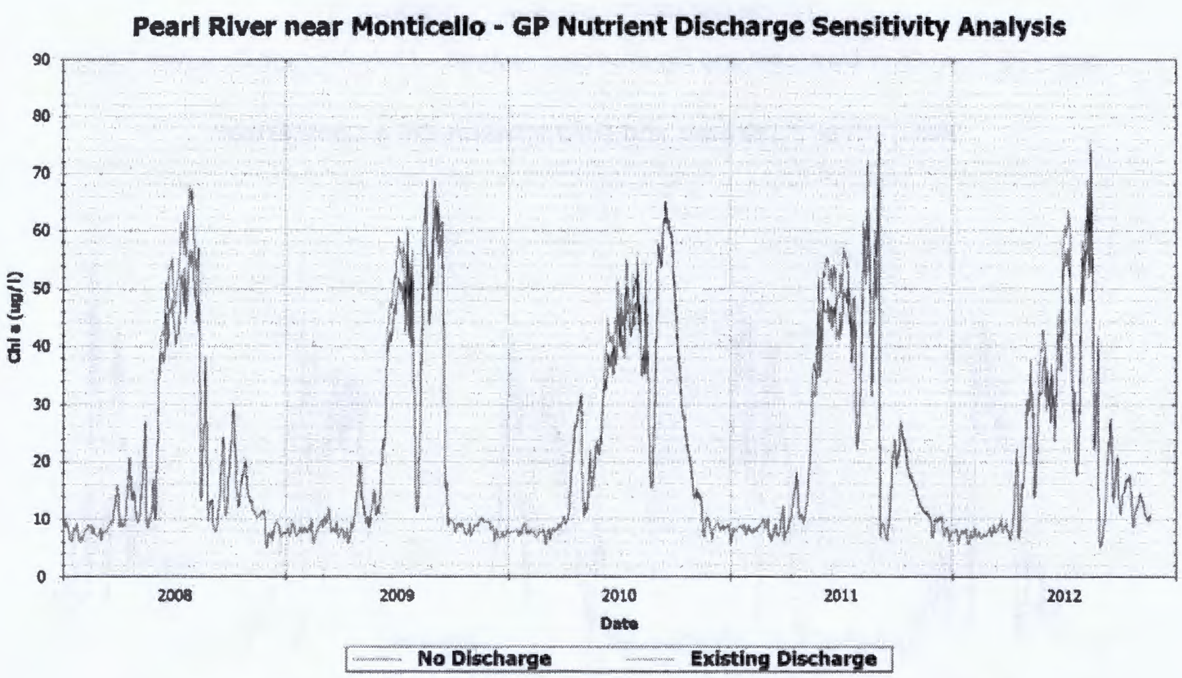

Figure 124 Pearl River Nutrient Sensitivity Analysis – Daily Average Chl a

Comparing upstream and downstream of GP Monticello's discharge, the DO levels upstream of the discharge exceed the DO saturation more than the levels downstream

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Ambrose, R.B., T.A. Wool, J.P. Connolly, and R.W. Shanz. 1988. WASP4, A hydrodynamic and water quality model – Model theory, user's manual, and programmer's guide. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Athens, Georgia.

Hamrick, J. M. 1992. A Three-Dimensional Environmental Fluid Dynamics Computer Code: Theoretical and Computational Aspects. The College of William and Mary, Virginia Institute of Marine Science. Special Report 317, 63.

Wool, T.A., R.B. Ambrose and J.L. Martin. 2001. Water Quality Analysis Simulation Program (WASP) Version 6.1. United States Environmental Protection Agency, Region 4, Atlanta.

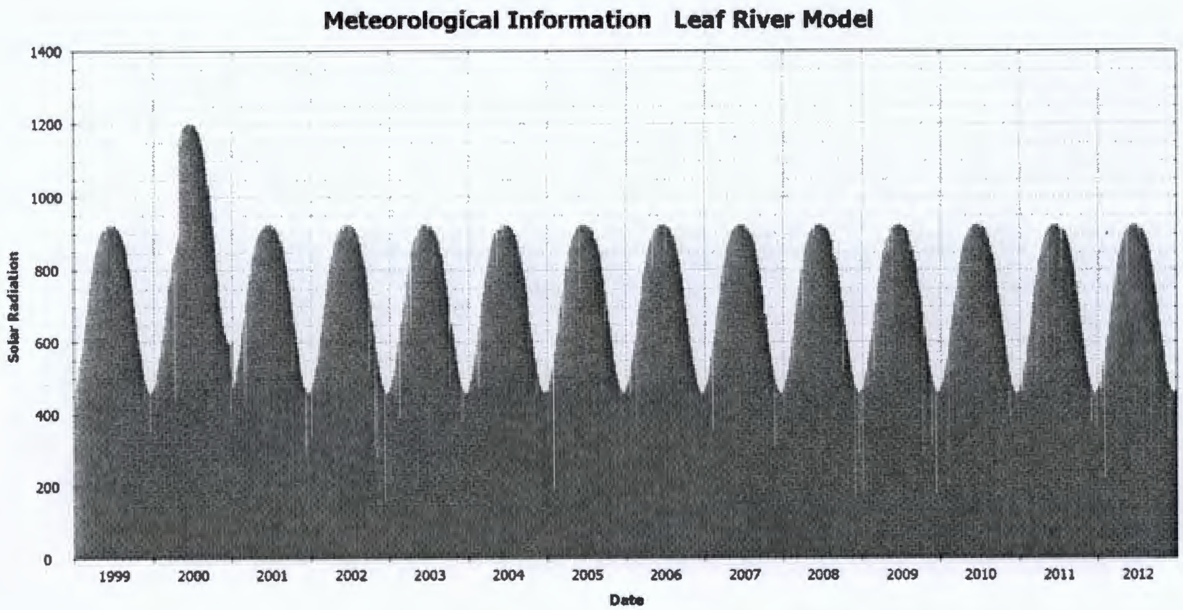


Figure 129 Solar Radiation

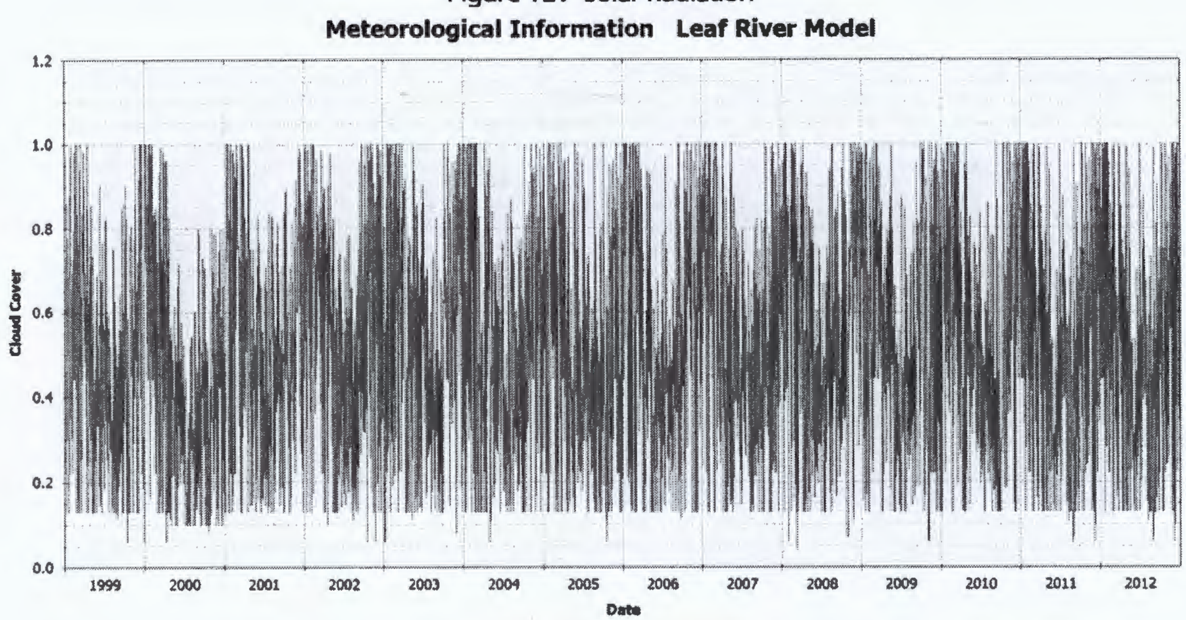
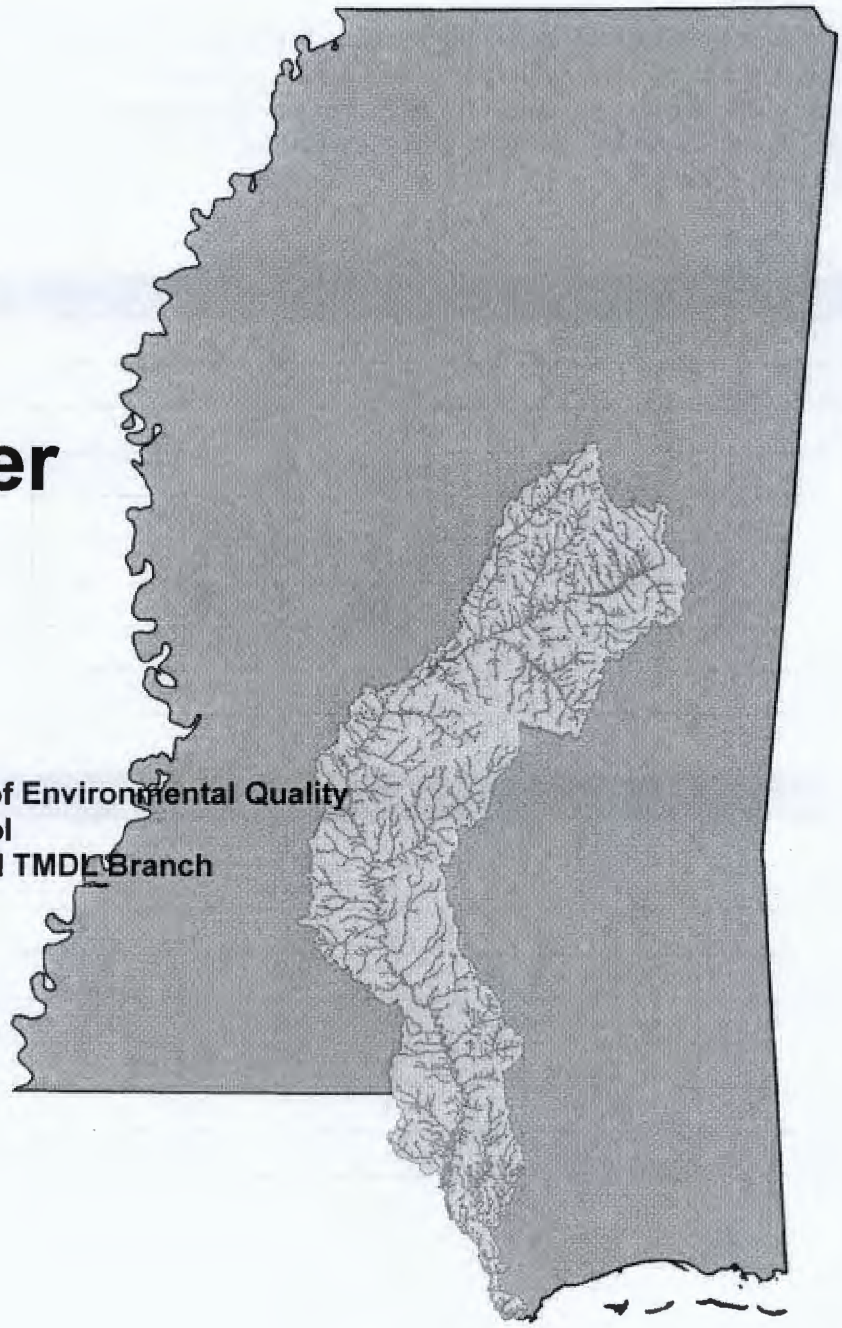


Figure 130 Cloud Cover

FINAL REPORT
June 29, 2009

Total Maximum Daily Load
Total Nitrogen and Total Phosphorus For the Pearl River



Pearl River Basin

Prepared By

Mississippi Department of Environmental Quality
Office of Pollution Control
Standards, Modeling, and TMDL Branch

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Jackson, MS 39225
(601) 961-5171
www.deq.state.ms.us

Mississippi Department of
Environmental Quality

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TMDL INFORMATION

Table 1. Listing Information

Name	ID	County	HUC	Evaluated Cause
Pearl River	MSUPRLRE	Neshoba and Leake	03180001	Nutrients
Pearl River	MSUMPRLR1E	Hinds, Rankin, and Copiah	03180002	Nutrients
Pearl River	MSUMPRLR2E	Leake and Madison	03180002	Nutrients
Pearl River	MSLMPRLRE	Simpson, Lawrence, and Copiah	03180003	Nutrients
Pearl River	MSLPRLRE	Marion, Pearl River, and Hancock	03180004	Nutrients

Table 2. Water Quality Standards

Parameter	Beneficial use	Water Quality Criteria
Nutrients	Aquatic Life Support	Waters shall be free from materials attributable to municipal, industrial, agricultural, or other dischargers producing color, odor, taste, total suspended solids, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated uses.

Table 3. Total Maximum Daily Load for the Pearl River Basin

	WLA lbs/day	WLA sw lbs/day	LA lbs/day	MOS	TMDL lbs/day
Total Nitrogen	12,747.6	416.9	22571.1	Implicit	35,735.6*
Total Phosphorous	2,549.4	46.4	2509.3	Implicit	5,105.1*

*TMDL applies such that TN and TP targets will be met in each of the impaired segments

EXECUTIVE SUMMARY

This TMDL is for the five segments of the Pearl River from the headwaters to the mouth at the Mississippi Sound, which were on the Mississippi 2008 Section 303(d) List of Impaired Water Bodies due to the evaluated cause of nutrients. Other evaluated causes of impairment will be addressed in separate TMDL reports. This TMDL will provide an estimate of the total nitrogen (TN) and total phosphorus (TP) allowable in this river.

Mississippi does not have water quality standards for allowable nutrient concentrations. MDEQ currently has a Nutrient Task Force (NTF) working on the development of criteria for nutrients. An annual concentration of 0.7 mg/l is an applicable target for TN and 0.1 mg/l for TP for water bodies located in the Ecoregion 65, which is the predominant ecoregion of the Pearl River Basin. MDEQ is presenting these preliminary target values for TMDL development which are subject to revision after the development of numeric nutrient criteria.

There are five river segments included in this TMDL, which are listed in Table 1 and shown in Figure 1. This TMDL focuses on the entirety of the Pearl River and major and direct point sources in the Pearl River Basin, which are listed in Table 4. This TMDL does not examine direct sources to the West Pearl River in Louisiana which diverges from the main stem of the Pearl River at Wakaiah Bluff in Pearl River County. This TMDL also does not examine nonpoint source loading from landuses that drain directly to the West Pearl River.

The limited nutrient information and estimated existing concentrations indicate reductions of nutrients can be accomplished with implementation of best management practices (BMPs) and reduction of TP from point sources.

1.3 Applicable Water Body Segment Use

The water use classifications are established by the State of Mississippi in the document *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2007). The designated beneficial use for the Pearl River above the Ross Barnett Reservoir is Fish and Wildlife. From the Ross Barnett Reservoir to the City of Jackson water intake, the designated beneficial use is Public Water Supply. The majority of the Pearl River, from Byram Bridge to the mouth, has a designated beneficial use of Recreation.

1.4 Applicable Water Body Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2007).

Mississippi's current standards contain a narrative criteria that can be applied to nutrients which states "*Waters shall be free from materials attributable to municipal, industrial, agricultural, or other discharges producing color, odor, taste, total suspended or dissolved solids, sediment, turbidity, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated use* (MDEQ, 2007)." In the 1999 Protocol for Developing Nutrient TMDLs, EPA suggests several methods for the development of numeric criteria for nutrients (USEPA, 1999). In accordance with the 1999 Protocol, "*The target value for the chosen indicator can be based on: comparison to similar but unimpaired waters; user surveys; empirical data summarized in classification systems; literature values; or professional judgment.*" MDEQ believes the most economical and scientifically defensible method for use in Mississippi is a comparison between similar but unimpaired waters within the same region. This method is dependent on adequate data which are being collected in accordance with the current nutrient criteria development plan.

1.5 Nutrient Target Development

Nutrient data were collected quarterly at 99 discrete sampling stations state wide where biological data already existed. These stations were identified and used to represent a range of stream reaches according to biological health status, geographic location (selected to account for ecoregion, bioregion, basin and geologic variability) and streams that potentially receive non-point source pollution from urban, agricultural, and silviculture lands as well as point source pollution from NPDES permitted facilities.

Nutrient concentration data were not normally distributed; therefore, data were log transformed for statistical analyses. Data were evaluated for distinct patterns of various data groupings (stratification) according to natural variability. Only stations that were characterized as "least disturbed" through a defined process in the M-BISQ process (M-BISQ 2003) or stations that resulted in a biological impairment rating of "fully attaining" were used to evaluate natural variability of the data set. Each of these two groups was evaluated separately ("least disturbed sites" and "fully attaining sites). Some stations were used in both sets, in other words, they were considered "least disturbed" and "fully attaining". The number of stations considered "least disturbed" was 30 of 99, and the number of stations considered "fully attaining" was 53 of 99.

WATER BODY ASSESSMENT

2.1 Water Quality Data

Nutrient data was collected on the Pearl River in the spring of 2008. Algal Growth Potential Tests (AGPT) were performed to determine the limiting nutrient in the Pearl River. The nitrogen, phosphorous, and AGPT results are presented in Table 5. A water quality study was conducted on the Pearl River in the summer of 2006 by USEPA Region 4 and DEQ. Nutrient and AGPT data were also gathered as a part of this study. The 2006 nutrient data and AGPT results are shown is Table 6. The AGPT results from the 2006 and the 2008 sampling show nitrogen is the limiting nutrient. Historically, there have been numerous water quality monitoring sites on the Pearl River that have collected nutrient data. A summary of this historical data is presented in Table 7.

Table 5. 2008 Nutrient Data and AGPT Results

Station Number	Station Location	Date	TN (mg/l)	TP (mg/l)	AGPT (mg/l)	Limiting Nutrient
A0450019	Pearl River at Pearlington	4/30/2008	0.95	0.10	6.3	Nitrogen
		5/28/2008	0.96	0.12		
A0490019	Pearl River at Rosemary Rd near Terry	4/22/2008	1.44	0.17	9.5	Nitrogen
		5/12/2008	1.45	0.25		
A0770166	Pearl River near Monticello	4/30/2008	1.58	0.16	9.2	Nitrogen
		5/27/2008	1.76	0.18		
A0910168	Pearl River near Columbia	4/30/2008	1.53	0.19	13	Nitrogen
		5/28/2008	1.18	0.15		
A1090004	Pearl River near Bogalusa	4/30/2008	1.11	0.12	3.2	Nitrogen
		5/28/2008	1.31	0.20		
A1210162	Pearl River at Florence Byrum Rd near Byram	4/25/2008	1.25	0.14	10	Nitrogen
		5/21/2008	1.14	0.15		
Site 2	Pearl River at Hwy 28 near Georgetown	4/30/2008	1.43	0.16	9.9	Nitrogen
		5/27/2008	1.55	0.15		

Table 6. 2006 Nutrient Data and AGPT Results

Station Number	Station Location	Date	TN (mg/l)	TP (mg/l)	AGPT (mg/l)	Limiting Nutrient
A0490016	Pearl River at Jackson at Impound Lot	8/23/2006	1.06	0.06		
		8/22/2006			3.5	Nitrogen
A0490017	Pearl River at Jackson WWTP above discharge	8/23/2006	058	0.05		
		8/25/2006			3.0	Nitrogen
A0490018	Pearl River at Jackson WWTP below discharge	8/23/2006	1.57	0.39		
		8/25/2006			20	Nitrogen
A0490019	Pearl River near Terry at Rosemary Rd	8/23/2006	2.43	0.14	NA	NA
A1210162	Pearl River at Florence Byrum Rd near Byram	8/23/2006	2.42	0.36		
		8/24/2006			38	Nitrogen
C0490033	Pearl River at Jackson at Water Works	8/23/2006	1.10	0.06	NA	NA

2.2 Assessment of Point Sources

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories of nutrients in the watershed and the amount of pollutant loading contributed by each of these sources. Under the CWA, sources are broadly classified as either point or nonpoint sources. Under 40 CFR §122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Point sources can be described by two broad categories: 1) NPDES regulated municipal and industrial wastewater treatment plants (WWTPs) and 2) NPDES regulated activities, which include construction activities and municipal storm water discharges (Municipal Separate Storm Sewer Systems [MS4s]). For the purposes of this TMDL, all sources of nutrient loading not regulated by NPDES permits are considered nonpoint sources.

This TMDL will focus on nutrient loads from major industrial and municipal WWTPs in the Pearl River Basin. The lower order streams in the basin that are potentially impaired by nutrient enrichment are the subject of separate TMDLs and are addressed in separate reports. The minor facilities are in other TMDLs or will not have an impact on water quality in the segments addressed by the TMDL based on professional judgment. Point source dominated freshwater systems are generally nitrogen limited. However, they may be made to be controlled by phosphorous by a TP reduction to point sources (Thomann and Mueller, 1987).

The wastewater from the facilities was characterized based upon the best available information. Kosciusko POTW and Philadelphia POTW are HCR facilities. Bogalusa POTW is located in Louisiana which is in USEPA Region 6. Literature values were used to estimate the mass loadings of TP and TN from municipal discharges (USEPA 1997). Estimated concentrations of TN and TP for different treatment types are given in Table 8 below (USEPA 1997). For the facilities that are not municipal discharges (Georgia Pacific Corp., Monticello Mill and Sanderson Farms Inc., Monticello) estimated existing nutrient concentrations were taken from the NPDES permit applications with the exception of the TN limit for Sanderson Farms which is a categorical limit. For Georgia Pacific estimated concentrations of 1.4 mg/l and 9.5 mg/l were used for TP and TN respectively. For Sanderson Farms estimated concentrations of 30 mg/l and 134 mg/l were used for TP and TN respectively.

Table 8. TN and TP Median Concentration in Wastewater Effluents

	Treatment Type			
	Primary	Trickling Filter	Activated Sludge	Stabilization Pond
No. of Plants Sampled	55	244	244	149
TP (mg/l)	6.6 ±0.66	5.9 ± 0.28	5.8 ± 0.29	5.2 ± 0.45
TN (mg/l)	22.4 ± 1.30	16.4 ± 0.54	13.6 ± 0.62	11.5 ± 0.84

There are 16 major or direct facilities that are shown in Table 9 below.

Table 10. MS4 Permits

Permit ID #	MS4 Name
MSRMS4026	City of Brandon, MS4 Storm Water Management Program
MSRMS4028	City of Flowood, MS4 Storm Water Management Program
MSRMS4019	Hinds County, MS4 Storm Water Management Program
MSRMS4024	MDOT, MS4 Storm Water Management Program
MSRMS4031	Madison County, MS4 Storm Water Management Program
MSRMS4007	City of Madison, MS4 Storm Water Management Program
MSRMS4025	City of Pearl, MS4 Storm Water Management Program
MSRMS4035	Rankin County, MS4 Storm Water Management Program
MSRMS4029	City of Richland, MS4 Storm Water Management Program
MSRMS4009	City of Ridgeland, MS4 Storm Water Management Program
MSS049786	City of Jackson, MS4 Storm Water Management Program

2.3 Assessment of Non-Point Sources

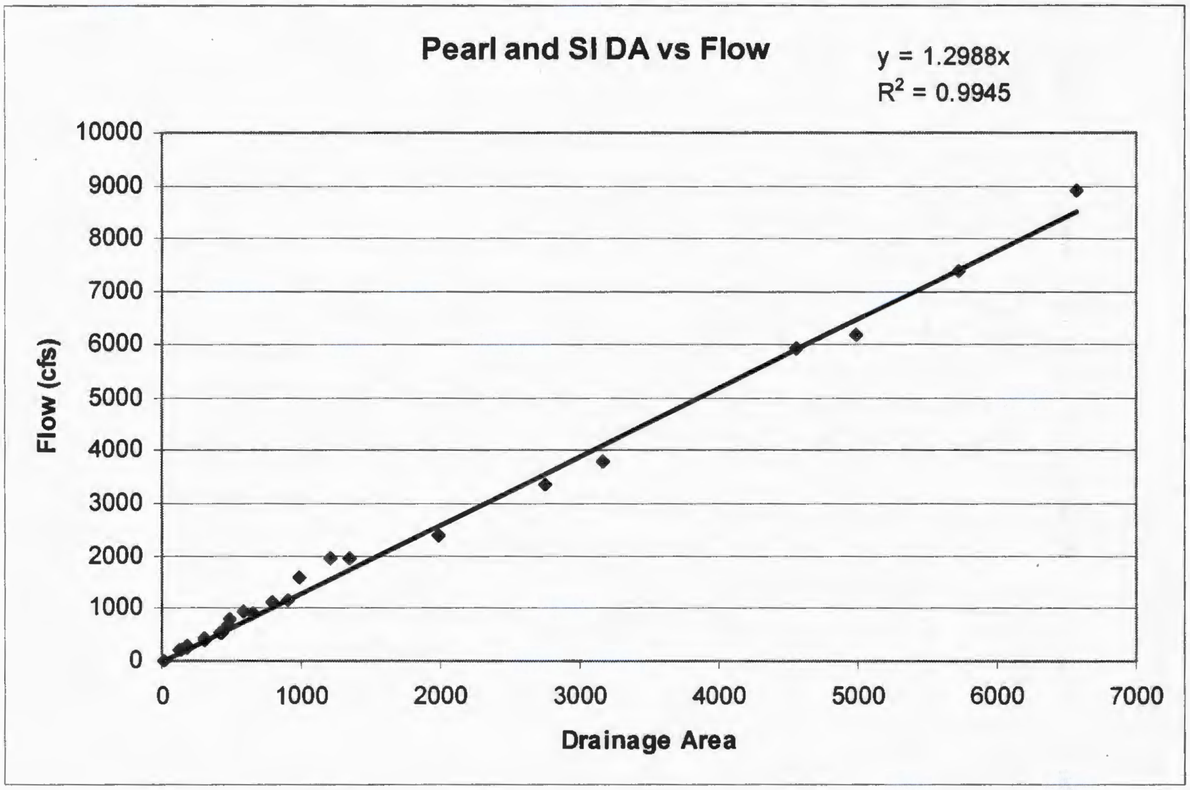
Non-point loading of nutrients and organic material in a water body results from the transport of the pollutants into receiving waters by overland surface runoff, groundwater infiltration, and atmospheric deposition. The two primary nutrients of concern are nitrogen and phosphorus. Total nitrogen is a combination of many forms of nitrogen found in the environment. Inorganic nitrogen can be transported in particulate and dissolved phases in surface runoff. Dissolved inorganic nitrogen can be transported in groundwater and may enter a water body from groundwater infiltration. Finally, atmospheric gaseous nitrogen may enter a water body from atmospheric deposition.

Unlike nitrogen, phosphorus is primarily transported in surface runoff when it has been sorbed by eroding sediment. Phosphorus may also be associated with fine-grained particulate matter in the atmosphere and can enter streams as a result of dry fallout and rainfall (USEPA, 1999). However, phosphorus is typically not readily available from the atmosphere or the natural water supply (Davis and Cornwell, 1988). As a result, phosphorus is typically the limiting nutrient in most non-point source dominated rivers and streams, with the exception of watersheds which are dominated by agriculture and have high concentrations of phosphorus contained in the surface runoff due to fertilizers and animal excrement or watersheds with naturally occurring soils which are rich in phosphorus (Thomann and Mueller, 1987).

Watersheds with a large number of failing septic tanks may also deliver significant loadings of phosphorus to a water body. All domestic wastewater contains phosphorus which comes from humans and the use of phosphate containing detergents. Table 9 presents the estimated loads from various land use types in the Pearl River Basin based on information from USDA ARS Sedimentation Laboratory (Shields, et. al., 2008).

The Pearl River Basin contains mainly scrub/barren but also has different landuse types, including urban, water, forest, pasture, cropland, and wetlands. The landuse information is based on the National Land Cover Dataset (NLCD). The landuse distribution for the Pearl River Basin without the West Pearl River landuse is shown in Table 11 and Figure 2. By multiplying the

Figure 3. Drainage Area and Flow in the Pearl River and South Independent Streams Basins



Nutrient Load (lb/day) = Flow (cfs) * 5.394 (conversion factor)* Nutrient Concentration (mg/L) (Equation 1)

ALLOCATION

3.1 Wasteload Allocation

There are 16 major or direct discharge NPDES point sources. Two of the facilities, Kosciusko POTW and Philadelphia POTW, are HCR facilities. The TN and TP limits for these two facilities will be based on concentration. The City of Jackson POTW, Savannah Street facility, currently has seasonal flow limits of 46 MGD in the summer (May – October) and 120 MGD in the winter (November – April). The average flow of this facility, taken from their NPDES permit application based on 777 samples, is 48.14 MGD. The TP and TN loads for this facility were calculated based on the summer flow of 46 MGD and are to be applied as a 30-day average load in the permit. Bogalusa POTW is located in Louisiana which is in USEPA Region 6. The WLA for 13 of the point sources is shown in Table 12. Three of the facilities are included in a nutrient TMDL for Tuscolameta Creek. The WLA for Tuscolameta Creek is included in Table 12 as a part of the Pearl River WLA (MDEQ, 2009). Future permits will be considered in accordance with Mississippi's *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification*(1994).

The AGPT results indicate that the river is nitrogen limited and needs to be driven back to being phosphorous limited. While this TMDL does not recommend a reduction to point source loading of TN, it does recommend quarterly monitoring of TN and applying the TN WLA load at these facilities. These limits are shown in Table 12. The estimated existing point source contribution of TN is 12,747.6 lbs and 36% of the TMDL target load.

This TMDL recommends an overall 56% reduction of TP from the 16 major facilities in the Pearl River Watershed based on the analysis given in Table 10. The estimated existing point source contribution is greater than the TP TMDL target load. Given the recommended TMDL percent reductions of 56% for TP, the WLA portion of the TMDL is 2,549.4 lbs. These limits are shown in Table 12.

3.1.1 Wasteload Allocation Storm Water

MDEQ has established a method to estimate the storm water waste load allocation (WLAsw). The WLAsw is calculated according to equation 2 below. The intent of the storm water NPDES permit is not to treat the water after collection, but to reduce the exposure of storm water runoff to pollutants by implementing various controls. Storm water NPDES permits require the establishment of controls or BMPs to reduce the pollutants entering the environment.

Waste Load Allocation Storm Water (WLAsw) = LA * % Urban Area in MS4 within watershed * 70%
(Equation 2)

3.2 Load Allocation

Based on the measured instream concentrations of TN from monitoring performed in 2006 and 2008, this TMDL recommends a nonpoint source reduction of TN. There is insufficient data to calculate a percent reduction for TN. This TMDL also recommends a 56% reduction to nonpoint source loads of TP based on the analysis given in Table 10. Best management practices should be encouraged in the watersheds to reduce potential TN and TP loads from non-point sources. For land disturbing activities related to silvaculture, construction, and agriculture, it is recommended that practices, as outlined in "Mississippi's BMPs: Best Management Practices for Forestry in Mississippi" (MFC, 2000), "Planning and Design Manual for the Control of Erosion, Sediment, and Stormwater" (MDEQ, et. al, 1994), and "Field Office Technical Guide" (NRCS, 2000), be followed, respectively.

3.3 Incorporation of a Margin of Safety

The margin of safety is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving water body. The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this model is implicit.

3.4 Calculation of the TMDL

A predictive model was not used to calculate the TMDL. Equation 1 was used to calculate the TMDL for TP and TN. The target concentration was used with the average flow for the watershed to determine the TMDL.

The nutrient TMDL loads were then compared to the estimated existing loads previously calculated. Best management practices are encouraged in this watershed to reduce the nonpoint nutrient loads.

Table 13. Calculation of the TMDL

	Flow (cfs)	Concentration (mg/l)	TMDL (lbs/day)	% Reduction
TP	9,464.4	0.1	5,105.1*	56%
TN	9,464.4	0.7	35,735.6*	0%

*TMDL applies such that TN and TP targets will be met in each of the impaired segments

CONCLUSION

Nutrients were addressed through an estimate of a preliminary total phosphorous concentration target and a preliminary total nitrogen concentration target. Based on the estimated existing and estimated target total phosphorous concentrations, this TMDL recommends a 56% reduction of the phosphorous loads from both point and nonpoint sources entering these water bodies to meet the preliminary target of 0.1 mg/l. NPDES permit limits for TP are recommended in Table 11. This TMDL recommends a reduction to nonpoint sources of TN but does not recommend a reduction to point sources of TN although it does set a TN WLA. The implementation of BMP activities should reduce the nutrient load entering the Pearl River. This will provide improved water quality for the support of aquatic life in the water bodies, and will result in the attainment of the applicable water quality standards.

4.1 Next Steps

MDEQ's Basin Management Approach and Nonpoint Source Program emphasize restoration of impaired waters with developed TMDLs. During the watershed prioritization process to be conducted by the Pearl River Basin Team, this TMDL will be considered as a basis for implementing possible restoration projects. The basin team is made up of state and federal resource agencies and stakeholder organizations and provides the opportunity for these entities to work with local stakeholders to achieve quantifiable improvements in water quality. Together, basin team members work to understand water quality conditions, determine causes and sources of problems, prioritize watersheds for potential water quality restoration and protection activities, and identify collaboration and leveraging opportunities. The Basin Management Approach and the Nonpoint Source Program work together to facilitate and support these activities.

The Nonpoint Source Program provides financial incentives to eligible parties to implement appropriate restoration and protection projects through the Clean Water Act's Section 319 Nonpoint Source (NPS) Grant Program. This program makes available around $1.6M each grant year for restoration and protections efforts by providing a 60% cost share for eligible projects.

Mississippi Soil and Water Conservation Commission (MSWCC) is the lead agency responsible for abatement of agricultural NPS pollution through training, promotion, and installation of BMPs on agricultural lands. USDA Natural Resource Conservation Service (NRCS) provides technical assistance to MSWCC through its conservation districts located in each county. NRCS assists animal producers in developing nutrient management plans and grazing management plans. MDEQ, MSWCC, NRCS, and other governmental and nongovernmental organizations work closely together to reduce agricultural runoff through the Section 319 NPS Program.

Mississippi Forestry Commission (MFC), in cooperation with the Mississippi Forestry Association (MFA) and Mississippi State University (MSU), have taken a leadership role in the development and promotion of the forestry industry Best Management Practices (BMPs) in Mississippi. MDEQ is designated as the lead agency for implementing an urban polluted runoff control program through its Storm Water Program. Through this program, MDEQ regulates most construction activities. Mississippi Department of Transportation (MDOT) is responsible for implementation of erosion and sediment control practices on highway construction.

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